THE ELECTRICAL WORLD

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A Lighting Plant of the Consolidated Electric Light Co.

At the southeast corner of Nassau and Liberty streets, in New York City, there stands a recently-constructed building, erected by the Mutual Life Insurance Co. at a cost of two million dollars. It is used for the offices of the insurance company, and for others to whom the company rent accommodations.

We believe it to be the first building of the kind, and of anything like its size and magnificence, to be predeterminedly and systematically wired for lighting by electricity generated within its own walls. Judging by what we have seen, the enterprise, which, but a short time ago, would have been considered hypothetically experimental, is an unqualified practical success. Therefore we are pleased to be able to describe the plant for the benefit of our readers.

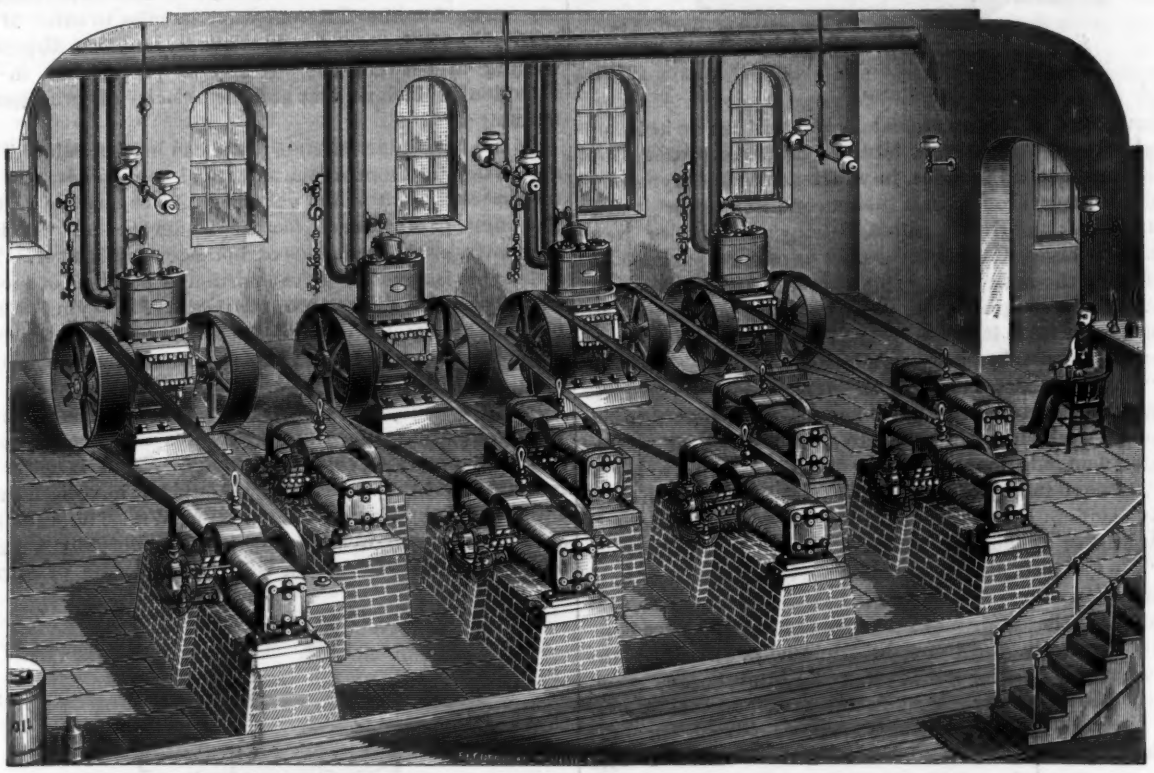


FIG. 1.—DYNAMO ROOM, MUTUAL LIFE BUILDING, NEW YORK CITY.

The sub-basement of this building is divided into rooms and vaults, for the accommodation of the boilers, engines, elevators, etc., and as store-rooms and the like used for the purposes of and by the tenants. Though two one-hundred horse boilers of the Babcock & Wilcox pattern stand ready for use when required, steam for the purposes of running the elevators, pumps, electric lights, etc., is taken from the street mains of the New York Steam Company.

In one of the rooms of this sub-basement are located the eight dynamos which are used for the purpose of generating electricity to supply the incandescence lamps used throughout the building. We illustrate by Fig. 1 this room and its contents. The eight dynamos are driven by four Westinghouse sixty horse-power engines. Each engine drives two dynamos by means of leather belts from its two band-wheels placed one at each extremity of the engine shaft. The engines need not be described, as they are familiar to our readers.

Each dynamo has the capacity to supply three hundred incandescence lights of 16 candle-power each. The plant may be said to be quite flexible in capability of running any desired number of lights within its extreme practicable limit of 2,400. We are informed that one of these dynamos has been run for hours to supply 356 lights.

During bright daylight only between two hundred and three hundred lights are used in the building. Consequently, only one dynamo is then run. During a dark day, or toward evening, more lights are used, so that another dynamo is run to supply electricity for them; and so on up to the limit, which, however, has not yet been reached, because only about 2,000 lamps have, as yet, been put in circuit. Furthermore, the construction of the dynamo is such that an approximately constant electromotive force is sustained, no matter what changes be made in the external circuit; therefore, a few, or many, lamps may be supplied with current appropriate to them under ordinary conditions of speed, etc. But in order to compensate fully for possible variations in these essentials, a manually variable rheostat for each dynamo is placed on the wall opposite the dynamo, and intercalated within its field-magnet circuit. The field-magnet circuit is a shunt from the binding-posts, as in the shunt-wound machines. In this circuit there is also placed a make-and-break key, by which to close or open the circuit. When the dynamo is to be put out of service this circuit is opened by the key. As, in consequence, no current flows around the field magnet, its inductive capacity is reduced to the minimum, and therefore, as no considerable current is generated, the lights go out. The variable rheostat serves as a means whereby the resistance of the field-magnet circuit may be varied, so that variations in the current flowing in it may be made to vary the strength of the magnetic field after well-known laws and practice.

The conductors from the dynamos to the external circuits are all carried to a switch-board conveniently placed on the wall of the dynamo room, and from which eight circuits are run to the story above, where each circuit is branched to parts of the building considerably apart. The switch-board is simply made, and is so constituted that any one of the dynamos may be put into any one, two, more or all of the circuits. In this way one dynamo supplies all the lamps used at times of minimum consumption; or for the other extreme, all the dynamos may be run to supply electricity for maximum requirements.

The mains and branches, having been placed while the building was in process of construction, are hidden from view, and are perfectly insulated and protected from casual damage.

The fixtures throughout the building are combined gas and electric, so that the tenants may use whichever of the two means of illumination they may choose. We have a slight suspicion that, as the whole plant was devised before confidence in the stability and reliability of electric light had reached its present state, it was thought best by the owners of the building, to be provided against failure of the new by having the old at hand. The eggs were not all put in one basket. The same is the case with the present reliance of the building upon the supply of steam for heat and power from the street mains—the Babcock & Wilcox boilers are held in reserve.

The advancements which have been made in electric lighting in the last two years have been such as to inspire a greater confidence in its reliability as well as in its superiority as a means of illumination. That which was thus doubtful in the public's appreciation has become a certainty. The producer and user of electricity now understands that duplication of apparatus is no more necessary in such cases than in others, in which electricity takes no part, but where absolute reliability is essential.

Each dynamo weighs about 4,800 pounds. The field-magnet cores are of cast-iron, and are made hollow from end to end, so that the atmosphere may have free access to the interiors for cooling purposes. They have consequent poles, and are somewhat longer than are some of those which they resemble under casual observation.

The supports for the boxes are of a non-magnetic metal, and are bolted to the under pole, instead of being cast of iron as one piece with that pole. This is a commendable feature, too often overlooked by dynamo makers. When made of iron, whether cast or bolted on, the magnetic lines of force are in part diverted from action on the armature, where, only, they are of any use.

The winding of the field magnets is in derivation, or shunt, and has a resistance of about ten ohms. The armature is made up of a hollow iron cylinder, open at both ends and fastened to the shaft, so that air may have access through the interior from end to end. Upon this cylinder there is built a superstructure of iron in strips and discs, so insulated as to avoid as far as possible Ampèrean or Foucault currents. After a due insulating wrapping over this iron cylinder, the insulated copper magnet-wire is wound longitudinally over all, after a modified Siemen plan, but only one course in depth, and with seventy convolutions.

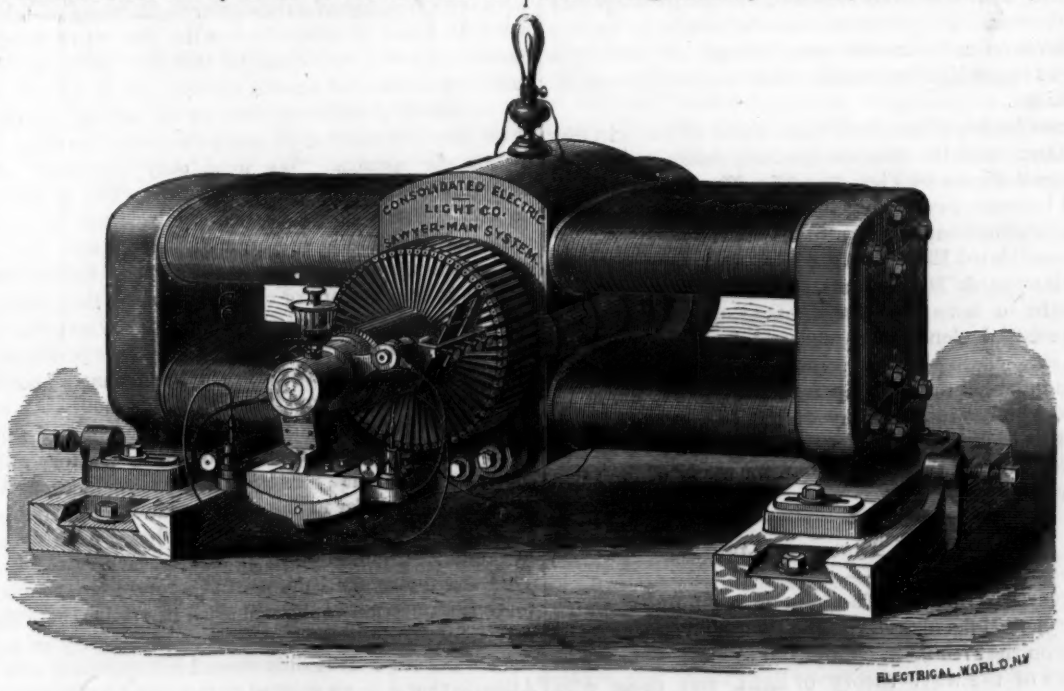


FIG. 2.—THE SAWYER-MAN DYNAMO MACHINE.

The collector, or commutator, has seventy segments, and resembles in all essential particulars the collectors of the Gramme and Siemens dynamos. The brushes pressing on the collector are four in number, *i.e.*, in two pairs, so that any one may be removed for repairs or exchange, and re-

placed without breaking the circuit or stopping the dynamo. The armature is 14 inches in diameter, is run at a speed of 900 rotations per minute, and has a resistance of 0.025 ohm.

The windings, as to resistances, and the proportions of iron in magnets and armature are such as to concentrate the field of force on the armature to the extent of overcoming the action of the current in the armature coils tending to form resultant poles and to change the neutral line on which it is necessary to place the brushes. Therefore, the line of collection of the current by the brushes is nearly coincident with the line bisecting the vertical line running from magnetic pole to pole; and the dynamo is of nearly constant electromotive force, no matter what the changes may be in the resistance of the external circuit. The electromotive force of the dynamo, as shown by the difference of potential at the binding-posts, is seventy-five volts.

One of the machines is shown by Fig. 2.

One of the lamps is shown by Fig. 3 in its holder, which also contains the switch by which the light is turned on or off. The filament is made from a carbonized vegetable fibre which, after carbonization, has been heated in an atmosphere of a gaseous hydrocarbon by means of an electric current passed through the filament and gradually increased in volume until the maximum of temperature, exceeding that to which the filament is to be exposed in practice, has been attained. During this treatment the weaker parts, those of the smallest cross section, become heated more strongly than the other parts, so that the adjacent hydrocarbonaceous atmosphere is decomposed, with deposition of some of its carbon constituent on the weak place to increase its cross section. This process renders the carbon filament of even quality throughout. The resistance of the filament is 110 ohms while hot. The filament is 0.006 of an inch diameter and has a quarter twist, as shown, to equalize the light in azimuth.

The leading-in wires are of platinum, and the filament is attached to them by small masses of carbonized cement. The globe is mounted in the holder by two clamping-lugs, which, by means of a screw, effect the contraction of the brass socket against the glass stem.

The base of the holder is made of vulcanite, and contains

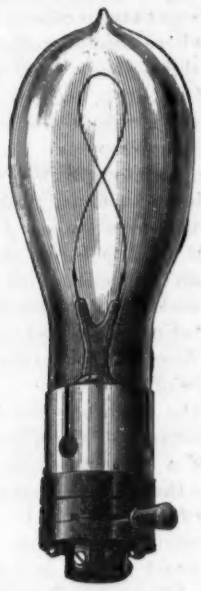


Fig. 3.

the switch. This differs from other switches in simplicity of construction. The circuit is made or broken by swinging the lever on a horizontal arc, instead of turning a wrench, as in gas-lighting and in other forms of incandescence fittings.

There are fusible plugs distributed about in the circuits in accordance with the underwriters' regulations. One of these plugs is shown by Figs. 4 and 5. The fusible plug is mounted between two spring contacts, as shown by Fig. 5. Fig. 4 shows the complete plug-mounting in wood.

The Consolidated Electric Light Co. are owners of the famous Sawyer & Man patents. Under them the company claim to have exclusive rights to the use of many of the essential elements of successful electric lighting systems.

We are indebted to the company's electrician, Mr. E. R. Knowles, who has made many of the improvements set forth in this description, and who laid out and superintended the work of this installation, for many of the facts herein written.

The Wave Theory of Light.

The lectures of Sir Wm. Thomson at the Johns Hopkins University, on Molecular Dynamics, which were brought to a close on the 17th inst., cannot fail to mark an epoch in the history of the wave theory of light, and those who have been in attendance, numbering some of the leading physicists and mathematicians of England and America, have enjoyed a rare opportunity. The lectures have been mainly directed to the great outstanding difficulties of the wave theory of light. None but a man of remarkable ability, who had spent many years in thinking upon great physical problems, would have ventured to undertake to work almost extemporaneously before such an audience upon these problems in which the most eminent mathematicians have failed. Those present should congratulate themselves on having been admitted into the laboratory, as it were, of a man of genius, and seen him fashioning the piece of work which was to be an exemplification of his skill. It is vastly more interesting and instructive to a thorough student to listen to such lectures than to lectures that are cut and dried and symmetrically bounded and limited. The audience was permitted to think with the lecturer and to follow the workings of his mind upon the difficulties to be solved, and was present almost at the very birth of the idea which relieved the wave theory of light of most of the difficulties left for solution by the discovery of an erroneous working hypothesis of Green, which has for half a century been accepted as rigidly true by such men as Stokes and Cauchy. "Mathematical literature," the lecturer says, "has

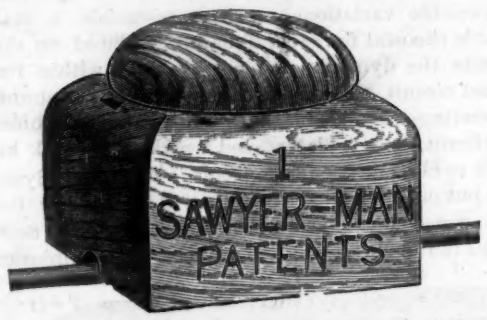


Fig. 4.

been loaded with a great deal of bad writing on this subject. There are a great number of investigations and statements called theories, in which a piece of dynamical work is gone through, and then a condition is arbitrarily introduced; and that is called Cauchy's theory, or Newman's theory or Gauss's theory. I have perhaps done injustice to the possessors of these three great names, who have done such great things. If we want not to put too fine a point upon it, we may call it Cauchy's mistake, or Newman's mistake, or Gauss's mistake."

"The most important branch of physics"—the lecturer began the course, striking the keynote with regard to the processes which he intended to use—"which at present makes demands upon molecular dynamics seems to me to be the wave theory of light. The wave theory of light is only beginning to demand imperatively applications of that kind of dynamical science.

"The first difficulty that meets us in the dynamics of light is the explanation of dispersion. Cauchy's explanation is to say that there is heterogeneousness through space comparable with the wave length. Helmholtz introduces the assumption of molecules loading the luminiferous ether, and somehow or other elastically connected with it. If we work out the explanation of dispersion at all, we must look definitely to times of vibration in connection with the property of the solid itself.

"We must not look upon luminiferous ether as an ideal thing. A real matter between us and the remotest stars I believe there is, and that light consists of real motions of that matter. A luminiferous ether that moves as if it were an elastic solid is the fundamental assumption of the wave theory of light.

"I wish to call your attention to a crude mechanical model in respect to representing the effects of dispersion. Suppose we have a number of concentric, rigid, massless shells, of small diameter in comparison with the wave length, the outer shell being connected to the first inner shell by a sufficient number of zig-zag springs; the first inner shell to the second by a sufficient number of zig-zag springs and so on; the last inner shell being connected to a solid nucleus by zig zag springs. We need only one inner shell to explain dispersion. We have then what is called for, namely, a definite period; and the relation between the period of vibration of the light considered and the period of the free vibration of the shell will be fundamental in respect to the attempt of a mechanism of that kind to represent the phenomenon of dispersion. When the period of luminiferous vibration is the same as the period of vibration of the shell we have also the mathematical conditions of absorption. It seems to me that this model as a symbol is certainly not an hypothesis, but an absolute certainty.

"But, alas for the difficulties of the undulatory theory of light, refraction and reflection at plane surfaces, as worked out by Green, differ in the most irreduceable way from the facts. A great many hypotheses have been presented, but none of them seems at all satisfactory.

"But suppose for a moment this might be mended, and there is a question connected with it, viz., Is the difference between two mediums a difference of rigidity or a difference of density? It is only since I left the other side of the Atlantic that I have worked at this thing. We are forced very much to the conclusion by the photometric experiments of Prof. Rood, of Columbia College, that the rigidity must be very nearly equal in the two mediums.

"The subject of double refraction in crystals is the great hopeless difficulty. I do not find it quite correctly stated in places where it is referred to. For instance, Lord Rayleigh says that Fresnel's view requires us to suppose the rigidity of the luminiferous ether to depend on the direction of vibration, which is not quite true. Fresnel's supposition that the plane of vibration is perpendicular to the plane of polarization proves, if it is true, that the velocity of propagation of light in a uniaxial crystal depends on the direction of vibration, and not on the plane of distortion. Lord Rayleigh puts forward the supposition that difference of effective inertia in different directions may be adduced to explain the different velocities of light in Iceland spar; but if that were the case the wave surface would not follow Huygen's law. Lord Rayleigh's idea is that the vibrating molecules might be like oblate spheroids vibrating in a frictionless fluid, which will have greater effective inertia when vibrating in the direction of the axis perpendicular to the flat side, less effective inertia when vibrating in the equatorial plane. Rankine was the first to make this suggestion. Stokes took away the poetry of it. He found, with minute accuracy indeed, that Huygen's construction was verified. I have myself great hopes that these spring arrangements are going to work us out of the difficulty. We can easily suppose them to have different strengths in different directions, and their law will give the thing we want, which is that the velocity of propagation of light shall depend on the direction of vibration, and not on the direction of distortion; and besides that, it will verify Huygen's law.

"But, alas, we have one difficulty which seems still insuperable, and prevents my putting this before you as the explanation of the difficulty. It is this, that I cannot get the requisite difference of effective inertia in different directions for the different wave lengths to suit. If we take this theory we should have anomalous dispersion coming in between the velocity of propagation in one direction in Iceland spar and the velocity of propagation in another."

Of the remaining lectures little can here be said. They are taken up from a mathematical standpoint, and are interspersed with many valuable and suggestive asides. The first part of each lecture is devoted to "molar" dynamics, or the dynamics of homogeneous matter. The latter part is devoted to the particular problem of molecular dynamics with which the lecturer is trying to supplement the molar dynamics wherever the theory of a homogeneous ether fails to account for the facts regarding light.

Lord Rayleigh, who has been in attendance, is credited with saying that, though these lectures were coming to an end, he did not see why they should. And it is to be regretted that the last difficulty should not have been overcome before the lectures closed. Sir Wm. Thomson has aroused a faith in others that he will eventually be able to explain double refraction with his molecule of spring

Fig. 5.

connected shells, in spite of his own assertion that this last difficulty of the wave theory of light seems an almost hopeless one.

Telegraphic Warfare in the South.

A dispatch from Texarkana, Ark., dated Oct. 15, says:

The contest between the Baltimore & Ohio Telegraph Company and the Western Union Telegraph Company over the attempt of the former to extend its rival system of telegraphs into Texas has been raging with more or less violence for the past 30 days. The general telegraph laws of Texas are very favorable to competing telegraph lines, and under those laws the Baltimore & Ohio Telegraph Company instituted proceedings to condemn a right of way between Texarkana and Sherman over the Texas & Pacific Railroad. The court awarded the railroad company $10 per mile damages, but gave the Western Union Telegraph Company nothing. The Baltimore & Ohio Telegraph Company deposited with the court the amount of the award and constructed its lines upon the Texas & Pacific Railroad. The Western Union Telegraph Company then applied to Judge Gaines, of the Texas State Court, for an injunction to restrain the Baltimore & Ohio Telegraph Company from occupying the Texas & Pacific Railroad Company's right of way through Lamar County until further adjudication of the condemnation proceedings. The injunction has just been denied, the court holding that commissioners having made an award and the amount being deposited with the court, the construction of lines could proceed without further hindrance. The Western Union also applied to Judge Gaines for an injunction to restrain the Baltimore & Ohio from prosecuting condemnation proceedings in Fanning and Red River counties. Also to Judge Estes for a similar injunction as to Bowie County, on the plea that they should be protected from a multiplicity of suits. These applications were also denied.

Quiet Telephony.

The Boston *Herald* of January 13,1884, had an article entitled "Quiet Telephony," which described an invention made by Mr. Henry F. Campbell of Concord, N. H., by which induced currents in electric wires—and especially in telephone wires, where they are the most annoying—were successfully prevented, thus enabling conducting electric wires of all kinds to be successfully used underground. The invention of Mr. Campbell was described as a combination of paramagnetic and diamagnetic metals, which was rolled into sheets or strips 1-300 of an inch in thickness. It was claimed, after prolonged experiment and the most exhaustive tests, that by means of this material, wound round a wire, electro-magnetic induction could be prevented; while, in the matter of static induction, by closing the ends of the shields and equalizing the shield circuit, it constituted a defence against all currents, whether from the earth, air, water or kindred wires. In concluding the article in question, it was said: "No other method hitherto known will answer with buried wires so well as the one here indicated; at least, this is what is claimed for it. If it will fulfill this promise, its value, indeed, cannot be overestimated. * * * If it will do anything like what is claimed for it, there will be no such thing as a telephone, telegraph or electric light company getting along without it. If, in fact, it will do what it claims to, thoroughly and effectually—and it seems to be at least scientifically correct in theory—it will prove to be one of the most important electrical inventions that have been made for some years—second only to the telephone itself." That was written a little over nine months ago. During this period, now adds the *Herald*, the Campbell system has been most thoroughly tested in a practical way. A line has been operated to Jamaica Plain, and one is now in operation between the office at 47 Devonshire street and the Highlands, the route of the line being chosen as the worst in Boston for induction, and the result has been invariable success. The crackling, creeping noise of the ordinary telephone wires cannot be heard in the wires protected by the Campbell shield, while the power and distinctness of the tone transmitted through the telephone are so marked that conversation can be carried on with pleasure, and not, as now, with the vexatious interruptions of scraps of messages and conversations passing over other wires. Dr. Clarence Blake pronounces the articulation over these protected lines the most perfect he has ever heard through a telephone. To test the system most thoroughly, the protected wire has been laid upon 50 kindred wires, some of them duplex and quadruplex telegraph wires, without the slightest effect upon it. Baron Von Wagstaffe, recently in this country on a special commission from the Russian government, gave the Campbell anti-induction system a careful investigation, and is reported as saying: "I fully indorse it, and on my return to St. Petersburg shall so report. I shall also call the attention of the younger Siemens of Berlin, to it. I am familiar with all the methods hitherto devised—the Lugo wire, the metal circuit, etc., but none of them are practical like this, and no one of them is so efficient in suppressing induction." Scientific men in large numbers, from Europe as well as America, have, after patient investigation, pronounced the discovery and invention of Mr. Campbell of great scientific value, and a practical accomplishment of what has been so long sought by electricians—a perfect conductor of electricity. Among the good qualities peculiar to the Campbell protected wires may be mentioned perfect quiet from all outside interruptions. Secrecy is thus secured to the business interests, to the news agencies and to the individual senders of messages by telegraph or telephone. Fogs, snow, ice and water do not impair the usefulness of this wire, as has been proved by actual work. Fallen wires do not affect communication on the protected wires, speech having been as articulate and distinct when eight or ten wires were pressed upon the south end line as when it was free from all line contacts.

The anti-induction shield, which is in the nature of a thin, narrow, metallic ribbon, is wound spirally around the wire and the shielded wire is then insulated by a process owned by the proprietary company. It is a marvelously cheap and effective method, as numerous experiments have shown. In results it achieves all that may be obtained by vulcanized rubber, while the expense is at least 40 times less than with rubber or gutta percha.

After the Electrical Exhibition.

At a meeting held in the Franklin Institute, Philadelphia, on the 15th inst., Col. Charles H. Banes, the Director General of the Electrical Exhibition, spoke upon its general results. He said it was not only a success financially, but in other respects as well. No profit was expected, but he was glad to say there would be a balance in hand of $10,000 after the building, shafting, etc., are paid for.

Speaking of the visits of the pupils of the public schools, he said that there were 13,162 such visitors to the exhibition; there were also pupils of 65 colleges and schools outside of the city who attended; 285,000 people visited the Exhibition; of this number 22½ per cent. was complimentary. The largest attendance during any one day was on October 7th, when 17,647 people were present; the smallest on September 3d, when 2,830 people were in attendance; the average attendance was 8,407 people; 105,000 electrical primers were printed.

Prof. Edwin J. Houston, the electrician of the Exhibition, spoke upon some telephonic novelties which had been exhibited.

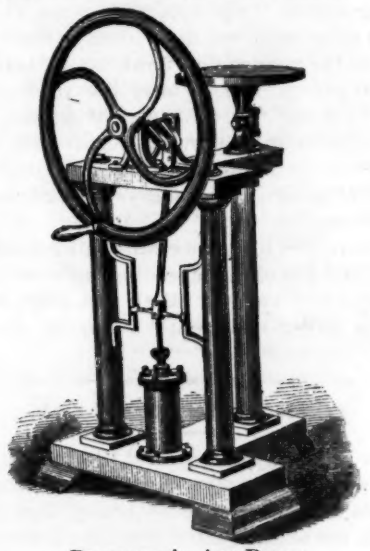
The result of the competition of the school children for the cash prizes offered by the Franklin Institute and THE ELECTRICAL WORLD for essays on the Exhibition will be made known in about a week or ten days.

Benjamin's Air-Pump.

Manufacturers of incandescence lamps and others often have need of a mechanical air-pump which is reliable and generally efficient. Mr. E. B. Benjamin, of No. 6 Barclay street, New York city, manufactures one which was designed by Prof. Charles A. Young of Princeton College. The accompanying figure illustrates it. It is operated by means of a crank-handle on the rim of a fly-wheel. The crank motion is converted into a reciprocating one so as to give vertical movement to the piston in the cylinder on the base. A valve opening upward into the cylinder closes that end of the tube leading to the centre of the platen through the standard in the rear, under the platen. The face of the platen is ground perfectly plane.

The piston has three valves in it opening upward. The valves have stems on their undersides, and the stems pass a short distance through the piston, so that when the piston is at its lowest point the stems have struck the bottom of the cylinder and so lifted the valves, as it were, from their seats. This is necessary, because when the exhaustion has proceeded to any considerable extent the pressure of the air above the piston would otherwise keep the valves closed, and there would be no escape for the air underneath the piston, unless it be compressed considerably above the free ordinary pressure of the atmosphere.

The pump is well and substantially made, with either



BENJAMIN'S AIR-PUMP.

wooden or iron frames. The iron framed ones are priced at $300. They are very useful in making exhaustions down to the point where the mercury pumps become necessary, because they work so much more rapidly. We have seen the mercury column fall 29½ inches from two or three strokes of the pump, and there remain, because the valves are good.

Scientists Relaxing at Baltimore.

A most pleasant dinner party was given at Johns Hopkins University on Friday, Oct. 16, by President Gilman to the scientists who had been brought together by Sir Wm. Thomson's lectures. The happiness of the occasion was only marred by the reflection that it was a farewell event. The feelings of all seem to have been concentrated in Prof. G. Forbes, of London, Eng., who broke forth into the following wail:

The lament of the 21 coefficients in parting from each other and from their esteemed molecule.

An aelotropic molecule was looking at the view,
Surrounded by his coefficients, twenty-one or two,
And wondering whether he could make a sky of azure blue
With platitatic *a b c* and thlipsinomic *Q*.
They looked like sand upon the shore with waves upon the sea,
But the waves were all too willful and determined to be free.
And in spite of *n*'s rigidity they never could agree
In becoming quite *subservient* to the thlipsinomic *P*.
Then *web*-like coefficients and a loaded molecule
With a noble wiggler at their head worked hard as Haughton's mule;
But the waves all laughed, and said a wiggler, thinking he could rule
A wave, was *nothing better* than a sidelong, normal fool.
So the coefficients sighed and gave a last tangential skew,
And *a* shook hands with *b* and *c* and *S* and *T* and *U*;
And with a tear they parted, but they said they would be true
To their much-beloved *wiggler* and to thlipsinomic *Q*.
Signed (*g*, *f*), a cross-coefficient, now anulled.

Sir Wm. Thomson pronounced the mathematics all right; President Gilman, the verse, and the sentiment was unanimously concurred in.

MOBILE, ALA.—The majority of the stockholders of the Mobile Electric Lighting Company met on Oct. 15. Col. J. H. Higley was chosen chairman and Col. Joseph Hodgson secretary. The following directors were then elected: O. F. Cawthon, Jas. K. Glennon, Joseph Hodgson, John E. Michael and Mark Lyons. The meeting then adjourned. The directors will meet and elect officers of the company.

An Electric Railway for the West.

The question of the application of electricity to railways is receiving considerable attention in the West. One of the latest and most notable schemes is that for the operation of an electric railway between St. Paul and Minneapolis, Minnesota. The St. Paul *Dispatch* of Oct. 7 has the following:

Mr. Geo. S. Bowen, representing the Van Depoele electric railway system, arrived in this city last evening and will meet the directors of the St. Paul & Elevated Railroad this evening, and lay before them the matter of constructing the road after the system he represents. The idea that Mr. Bowen will put forward is to construct, where it is necessary, steel posts twenty feet high, erected in forty feet bents. The trucks of the car are on the top and the car is suspended from the rails twenty feet in the clear above the street. The trucks are so constructed as to be noiseless, and the rails are deadened so that the wheels will make no noise in running over them. The motor is of the type of the standard dynamos manufactured by the Van Depoele Electric Light Company of Chicago. The central station can be built at either end of the line and at this the electric current is generated and will supply all the power that the business will demand. There will be a double track of the standard gauge, and each train will contain three cars with a seating capacity of 60 people.

Mr. Bowen assured the reporter that he could make the run to Minneapolis in six minutes, and that the regular running time, including three or four stops, would be ten minutes. The system is at work in Toronto, Can., and a telegram from R. G. Lunt, a wealthy banker of that place, says that it is a perfect success, and that the public is highly delighted. The road that is to be constructed in New Orleans is to have two cars on one set of trucks, one on top and the other suspended below; the top car to be the smoker. The beauty of this system is that there is no danger, it furnishes rapid transit, there is no dust, and it is out of the way.

Mr. Bowen further states that if the two cities will give the right-of-way and councils will pass the right ordinances, he is prepared to furnish the money to construct the road, which will cost in the neighborhood of $1,000,000. This, however, will hardly be the result, as the directors who meet this evening have about decided to accept this system. It is without doubt the greatest enterprise that has ever been set on foot in either of the cities, and, when it is successfully culminated, as it is sure to be, it will be one of the grandest institutions in the world, and the two cities can point to it with pride.

Electric Lights in Philadelphia.

At a meeting of the Gas Committee of Philadelphia Councils, on October 14th, it was decided to recommend an appropriation of $2,000 for lighting Columbia avenue, from Ninth to Broad streets, with electrical lights; also $3,000 for lighting South street in the same manner from Delaware avenue as far as the amount will permit; also $2,000 for lighting Locust street, from Seventh to Thirteenth streets, in like manner; and $4,000 for lighting Federal street, from Broad street to Gray's Ferry road, and Gray's Ferry road to the bridge, with the electric lights.

With the double row of electric lights on Chestnut street, from the Delaware to the Schuylkill, these improvements will make Philadelphia one of the best-lighted cities in America. The competition in that city is becoming very brisk, as may be seen from the following:

"We will light Rittenhouse, Independence and Washington Squares, lay all the wires and furnish not less than seventeen lights to a square until the beginning of the year for nothing," stated Mr. N. H. Johnstone, of the Underground Electric Light and Power Company, before the City Property Commission recently. "And further," he continued, "it will not cost the city one penny for repairs."

"How about payment?" queried one of the Commissioners.

"If the city asks for a bill, we will at the end of that time charge fifty cents a night for each light, and run our chances of procuring the contract for next year."

This proposition was received and ordered sent to Councils with a favorable recommendation.

MAGNETISM.—The second of a series of lectures on magnetism was delivered before the Electrical Society last evening, says the Buffalo (N. Y.) *Courier* of Oct. 16, by William Finn, of the Western Union Telegraph Company. The lecturer dwelt at length on the inductive action of the earth's magnetism and its influence upon the compass and dipping needles, and he showed by experiment that the placing of a bar of iron or steel parallel with the dipping needle converted the bar into a magnet. Several other methods were also described. The most interesting experiments were those of the various magnetic spectra shown by means of iron filings strewn upon a piece of cardboard placed above a number of variously disposed magnets. The general character and distribution of the curves or lines of magnetic force were by this means beautifully illustrated. Another very interesting and novel experiment was shown in magnetic writing, drawn upon a couple of steel plates by means of a magnetic knitting needle. The writing, which was perfectly invisible in itself, was made manifest to the audience by means of fine iron filings scattered upon the steel plates. Such sentences as "Cleveland and Hendricks" and "The Electrical Society extends a welcome to all" were plainly seen.

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NEW YORK, OCT. 25, 1884.

THE FUTURE OF SECONDARY BATTERIES.

To-day we finish our report—the only full report published—of the interesting and important discussion at the National Conference of Electricians on the subject of secondary batteries. The length of the discussion, which fills no fewer than six of our pages in solid brevier, is a remarkable evidence of the manner in which the storage question is still exercising the minds of leading electricians; and the whole drift of the remarks goes to prove that the fore-look is decidedly hopeful. This latest word on secondary batteries is by no means the last, and we think it marks the time at which "storage" rises out of the marvel stage, through which apparently all great electrical ideas must pass at the cost of dupes, into the scientific, experimental and finally practical stage, when commercial development is merely a question of time and of business ability.

The practical bearings of the subject were admirably treated by Mr. W. H. Preece, than whom no man is more opposed to a viewy and visionary consideration of electrical questions. Accepting and concurring in Mr. Edison's famous remark on the capacity of storage batteries to develop man's latent genius for lying, and adding: "I think there has been more lying and more swindling and more rascality done over this question than over any other department of electrical science," Mr. Preece went on to give his inspiriting testimony in favor of secondary batteries made and used on the lines of Planté's original methods. He described to the Conference the successful utilization of secondary batteries in working the English postal telegraphs, in lighting up English railway trains, and in lighting his own house; and if we may judge from our personal sentiments, there were very few in his audience who, while wishing for the day when they could light their homes in a similar manner, did not feel a conviction that the arrival of that day when such storage will be a commonplace of electrical application cannot be long postponed.

ELECTRIC RAILWAYS.

As soon as the present business depression comes to an end—perhaps we should say "after election"—electric railways are to enjoy a large share of public notice. Last week the street car proprietors, managers and superintendents of the country met in New York, and their deliberations show them to be all of much the same mind in regard to the application of electricity to street locomotion. They are reported to have agreed in the belief that it was speedily "coming." Recently the Daft system of electric railways has been in operation at Coney Island and Boston, and we understand that other short lines on the Daft plan are in contemplation. The Van Depoele system has been successfully used at Toronto, is likely to be used at New Orleans, and has been chosen for a road between St. Paul and Minneapolis, on about nine miles of elevated track. The Griscom and the Bidwell systems were exhibited at Philadelphia. The Knight-Bentley system has been in operation at Cleveland, is now covered by a number of patents, as mentioned in our patent record this week, and is offered for the Brooklyn Bridge, on which it would work admirably. If these are the signs in dull times we may reasonably expect great activity in electric railroading as soon as the country comes round to the conviction that the pessimistic view of trade and commerce does not fit all the facts of the case.

What can be done with electric railways is exhibited in the figures now lying before us of the Brighton Volk line, and of the Traill system at Portrush, Ireland. The Brighton line, along the sea front, has now been in active operation for six months. The car mileage amounted to 15,600 miles, and the passengers numbered 200,000. The consumption of gas in the gas engine driving the dynamo was 300,000 feet, and the total cost of operation was about 4 cents per mile run. The enterprise is paying a handsome profit, and its only drawback is that it is hardly on large enough scale for the number of passengers to be carried. The Giants' Causeway Electric Tramway, of which Mr. W. A. Traill, Portrush, is the engineer, is a most pronounced success. It has already been stated in these columns that the line is six miles long, and derives its current from dynamos driven by turbines in the Bush River, more than a mile distant from the tramway. The current is conveyed to the line by ordinary wire. The track is one continuous series of inclines of gradients up to 1 in 25, the summit level being 160 feet above the two termini. Under these conditions, the tramway has during a period of nine months, according to figures kindly furnished by Mr. Traill, run 13,000 electric train miles, and the report for the half year ending August 8, 1884, states that in that period 9,240 miles were run at an average rate of ten miles per hour. In the year ending June 30, 1884, the number of passengers exceeded 60,000 and the road also carried, principally by electricity, 6,000 tons of goods. Mr. Traill gives, in confirmation of previous reports, the figure of 5 cents per electric train mile run with accommodation all the time for 44 passengers, and says the tramway is doubling its business.

Here we have two roads, one converting gas into electrical current, and the other depending on water-power that would have been wasted. Both are successful, and if worked on a larger scale would naturally show a larger percentage of net earnings.

COMMUNICATION AT SEA.

This paper has always recognized the necessity, and has several times pointed out plans, for communication between vessels at sea, especially during heavy fogs and snow-storms. The use of antiquated systems of colored flags by day and pyrotechnics by night is nothing less than criminal while intelligent communication may be had at all times, in all weather, by means of a fog-horn and the Morse code. The New York *Herald* of Oct. 19 contains a very fair adaptation of the idea. It shows how, by our skippers relying upon the old-time system of guesswork and good luck, we have 200 collisions at sea in one year in a fleet of 60,000 sea-going vessels. But, while the *Herald* man advocates the Morse code by means of long and short blasts of a powerful whistle, he makes the mistake of advocating the International code with its complicated signals—"H. B.," for "Want immediate assistance;" and "D. M. W. G.," for "Pirates reported off ——," all of which requires a book for careful reference. With the Morse code, plain and simple, there could be no need for codes of any kind, since vessels could literally "speak" to each other. This plan would necessitate the employment of an operator on every ocean vessel, but it would pay, since the operator could also act in the capacity of purser or clerk to the captain. If some of our fast Liverpool lines would give this sweeping plan a fair trial, they would increase public confidence and so gain additional safety as well as additional patronage. In fact, now that so many steamers carry dynamos for electric lighting, and that scientists like Profs. Bell and Trowbridge and Mr. W. H. Preece are experimenting in electrical communication at sea, as detailed in our columns last week, it seems reasonable to look forward to the not remote time when every ocean steamer will number an electrician among its officers, on deck or in the engine room.

"PROFESSORS OF ELECTRICITY."

In reply to a correspondent, the New York *World* states that "there are no 'professors of electricity' in any college in this city." This may be true, but is misleading, as there are a great many professors in and around New York who teach electricity, although they may be known professionally and officially as professors of physics. Taking the whole country, it would be hard to find a dozen "professors of electricity," but the number of professors giving instruction, in colleges, on electricity is by no means small. The late Exhibition and the Electrical Conference at Philadelphia were remarkable for the muster they made of professors. The Exhibition was mainly "run" by professors, and in reporting the proceedings of the Conference the newspapers of the city, to be on the safe side, dubbed every man "professor."

Exhibits at the International Electrical Exhibition.

IV.

Below are further notes on some of the exhibits:

REMINGTON STANDARD TYPE WRITER.

Many of our readers will be interested in knowing that the type writer was among the exhibits, being used there in taking dispatches direct from the ordinary sounder, with entire success. The advantages of taking messages in this way are obvious. The copy is much more legible, and the use of the machine enables the receiving operator to manifold the required number of copies. The fatigue and cramping of the operator's hand as experienced in the old way with the stylus are avoided. The speed with which the type-writer can be operated by a good hand (75 or 80 words per minute) enables the operator to receive much more rapidly than by the old method with the pen. The ease with which the work is done is very gratifying to the operator who has been wont to find more fatigue than pleasure in his daily toil. The time seems to be coming when messages will very generally be received in this way, and, should a more rapid system of sending be adopted, the type-writer will be necessary in order to give the receiving operator the means of keeping up. There are now several Remington machines in use in the operating room of the Western Union Company, at 195 Broadway.

AMERICAN ELECTRICAL WORKS.

Fine wire of uniform diameter and absolute size has been a long felt want among the makers of electrical apparatus, more especially within the last few years, when more attention has been given to the subject. Wire of approximate size, or such as would pass inspection with the ordinary slotted gauge, will but seldom meet the requirements of the work of most consumers at the present time. The slotted gauge has given way to the micrometer gauge, and size is now specified by thousandths of an inch. A large portion of the fine wire drawn for electrical use has proven more or less out of size. Two samples of equal length cut from the same coil would give a different resistance when tested. When measured by the micrometer gauge, frequently a difference of from 4 to 5 thousandths of an inch would be found in the diameter at different places. For instance, copper wire No. 24, B. & S. gauge, which should have a diameter of twenty thousandths of an inch has been found to measure from eighteen thousandths to twenty-three thousandths of an inch. The resistance of a given length would accordingly vary, and hence, in the winding of electro-magnets, the actual results in resistance would ofttimes be more a matter of conjecture than calculation. Experiments have been conducted at the factory of the American Electrical Works, Providence, R. I., with a view of producing wire free from the defects mentioned, and with a view of securing long lengths without joining by soldering or brazing. We are not acquainted with the details of the process further than to understand that they are improvements upon existing methods of wire drawing and subject of pending letters patent.

We have seen micrometer measurements made of samples selected at random that would suit the most fastidious and that are most convincing. The samples of very fine copper wire Nos. 36 and 37 B. & S. gauge, respectively 4½ and 5 thousandths of an inch in diameter, shown at the Electrical Exhibition in lengths of 5 miles each, of unvarying diameter from end to end, attest more than words to the above statement. German silver wire, which is known to be difficult to draw, yields readily to the manipulations of the process, and stands the most rigid micrometer tests. A lot of No. 40 B. & S. German silver wire, three-thousandths diameter, has just been produced and double covered with silk for a prominent manufacturer of electrical testing apparatus, which is a curiosity for length and perfection of covering. The American Electrical Works now draw all the fine wire used by them, and, as may have been noticed in their special advertisement, offer the same for sale in competition with the product of other manufacturers. Their facilities for covering fine wire with cotton or silk are said to be the largest in the country, occupying two entire floors of their largest building. Their patent rubber covered wire has stood the test of time. It is made by machinery from sheet rubber of the best quality. It is covered longitudinally in long lengths by a process which places the conductor in the exact centre of the rubber, and secures it in this position. This is a step in advance of other methods, as during the vulcanizing process the conductor settles more or less, and in consequence the insulation is found of unequal thickness on opposite sides of the conductor. This is claimed to be impossible with their treatment. The Rubber Anti-Induction Cables, made by the same process, speak for themselves by length of service. They are light in weight and thoroughly protected from influences of the weather by a rubber covering and a weaving of linen, which is afterwards painted. We are informed that they have been working successfully in Providence and Boston for three years, as well as in numerous other cities for nearly as long. The Patent Finished Varnished Wire is,

as the name implies, finished with a coat of varnish which makes it attractive to the eye, especially so when finished in colors, as well as more thoroughly waterproof. The spiral telephone cord needs no recommendation. It can be found connected to nearly every set of telephone apparatus in the country. We are informed that it is no unusual occurrence for this firm to ship from two to three barrels of telephone cords in one shipment. As an ordinary barrel will hold about 1,500 cords, the question naturally arises, what becomes of all of them? The electric light wires, burglar alarm and annunciator wire, lead encased wire, various cables and telephone cordage shown at the Exhibition, need no particular mention, as they are well known to the trade throughout the country.

The Gerard Dynamo-Electric Machines and Lamps.

Messrs. James W. Queen & Co., of Philadelphia, exhibited at the International Electrical Exhibition some of the dynamos, lamps and other apparatus for electric lighting, made by the *Société Anonyme d'Electricité* of France, under the French patents to A. Gérard. We illustrate herewith some of the apparatus made by this concern, for which Messrs. Queen & Co. are the agents.

Fig. 1 shows the dynamo for currents of one direction. These are made of various sizes for various powers and purposes. The smallest gives a current equal to that from three Bunsen cells, and is operated by hand. The largest is made to supply fifty arc lamps. The largest exhibited, however, was that designated as "No. 2," and which has a capacity to supply one lamp of about 300 carcels illuminating power, when driven by three horse-power. This size of machine is ordinarily used as an exciter of the Gérard Alternating-Current machines.

The machine, Fig. 1, has a cast-iron annular frame, placed with its open end, in the vertical plane. Upon one end a yoke is cast to carry the box for one end of the armature axis. This yoke is horizontally diametrical to the annular frame. A like yoke on the other end is bolted to the frame, so that it may be readily removed for convenience in inserting and removing the armature.

On the inside periphery of this annular frame are bolted four electro-magnets, the cores of which are arranged radially, and 90 degrees from centre to centre of one another. They are wound with magnet wire in series, so that when an electric current flows in the wire the free pole-ends of the electro-magnets are of alternate polarity. That is to say, a north pole has a like pole diametrically opposite to it, and a south pole upon either side of it. The same is the case with the two south poles.

Sometimes these electro-magnets are wound with coarse wire to carry the entire current of the machine, as in series-winding, and sometimes they are shunt-wound. This latter is to say that they are wound with very long and fine wire, and that only part of the current generated in the armature is carried through this fine wire and around the electro-magnets. These magnets which we have been describing constitute the field-magnets of the dynamo.

The armature core is built up of sheet iron, the several layers of which are insulated from ·· other. Each piece of sheet iron is in the form of a cross of equal arms, radially placed, and 90 degrees apart and with a central hole to receive the axis. The coils placed on this compound armature are so connected that the free ends of the arms would be magnetized alternately north and south if run as an electric motor. They are sometimes connected up in parallel, and sometimes in series, according to whether currents of intensity or of tension are required.

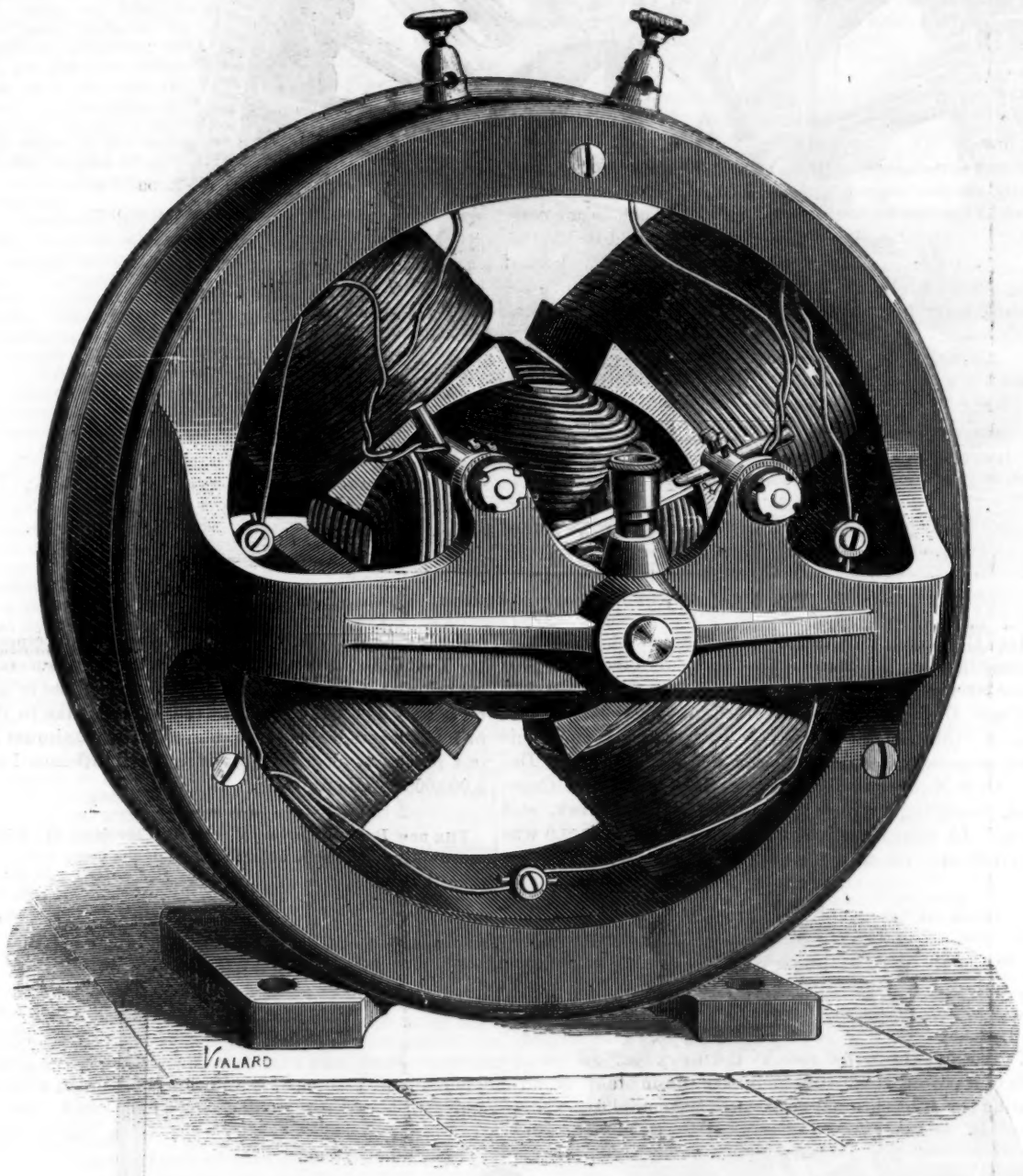


FIG. 1.

The commutator is made up in four sections, but diametrically opposite sections are electrically in contact. The brushes bear upon the commutator at points only 90 degrees apart instead of 180 degrees as in most other dynamos. The point of change of direction of current impulses is where the armature poles *leave* the field poles. As diametrically opposite poles both leave two poles of the same name, but of opposite name to their own, at the same time, commutation must take place at points 90 degrees removed, because it is at that distance that the poles of the armature and of the field are unlike, collectively considered.

Engineering gives the following table relating to some of these machines:

Numbers.	Volts.	Ampères.	Revolutions.	Number of incandescence lamps.			Horse-power.
				10 c. p.	25 c. p.	50 c. p.	
0s	35	7	2,500	6	3	2	½
1	60	10	1,800	15	10	6	1
2	75	15	1,800	28	18	12	2
3	100	20	1,600	50	30	20	3

Fig. 2 shows a large alternating current machine, built by this firm, designed to run either 1,000 arc lamps or 3,000 incandescence lamps, or combinations of the two. It is driven by a Corliss steam engine of 250 horse-power. The exciting electro-magnets are mounted on the fly-wheel of the engine. The stationary bobbins are upon both sides of the fly-wheel. The principle is the same as in the Ganz, Gordon, Siemens and other alternating current machines. The rotating field-magnets are excited by the current from a large dynamo such as shown by Fig. 1.

Fig. 3 shows a smaller machine of the same kind, but which is to be run by a belt from the engine. This is capable of being coupled up in various combinations to run arc lamps of various sizes, or varying numbers of incandescence lamps, or both. So it may be used in hotel lighting for the courts, halls, and small rooms independently, according to the several sizes of lights required.

Fig. 4 shows the Gérard incandescence lamp. For the filament in other lamps of the type there is substituted two attenuated rods of carbon, made as are the rods for arc-lights, and mounted in a peculiar manner. The leading-in wires have cemented to their ends within the exhausted globe two small carbon hollow cylinders. Into these cylindrical cups the lower ends of the two fine carbon rods are cemented by a carbonaceous cement. Their upper ends are brought together and there fastened by some of the same cement.

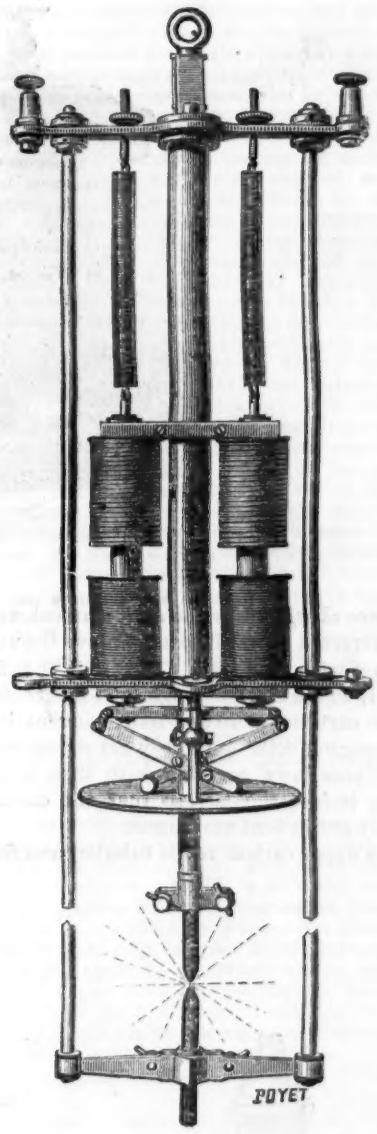


FIG. 5.

The following table we take from *Engineering*. It gives the particulars of the various sizes of these lamps:

Numbers.	Candle-power.	Volts.	Ampères.	Price.
				Francs.
00	3	6	1	5
0	10	20	1¼	8
1	25	20	2	10
2	50	40	2½	12
3	100	50	5	13
4	200	60	7	15
5	400	70	7 and 8	30
6	800 to 1000	..	..	125

An arc-lamp is shown by Fig. 5. It is differential and is designed for a "factory lamp," and is adapted to alternating currents. The two lower electro-magnets are wound with fine wire and are placed in derivation, that is, in shunt around the arc. The two upper ones are in the main circuit. At the top of the core there are two short cylindrical masses of soft iron called the armatures. These are suspended by the two spiral springs with regulating screws. From the under side of the armature two metal rods run through the cores of the electro-magnets, and at their lower ends they are fastened to the horizontal cross-piece to which the two X-placed levers are attached at their upper ends.

The X levers carry each a half of a clamp which encircles the upper-carbon carrying rod. The circular table below is adjustable as to height. When the lower ends of these X-levers rest on the table the clamps are freed from engagement with the carbon-carrying rod so that it may slip down in feed movement.

When not in action the carbons are together, because the upper springs do not pull enough to raise the carbon and attachments. But as soon as current flows, the magnets are energized by the main current, and the armatures are attracted upward, so as to move the upper carbon from contact with the lower. The arc is thus formed.

But, as the arc gets longer and longer, from combustion of the carbons, more and more current is diverted to the fine magnet coils, until they get strong enough to pull the armatures down, together with their attached levers and clamp to free the last, so that the carbon rod may slip downward in feed movement.

The upper carbon rod is tubular, and fits like a piston in he larger central tube suspended from the top of the lamp.

The same concern makes a lamp of like general appearance, but there are only two coils instead of four, and they are of fine wire in a shunt around the arc. When no current is flowing, the carbons are apart. But when circuit is made, the armatures are pulled down to bring the carbons together, and then most of the current flows through the carbons so that the springs separate them, because the electro-magnets are thereby weakened. The feed movement is effected as in the preceding lamp.

It also makes a modified Jablochkoff candle shown by Fig. 6.

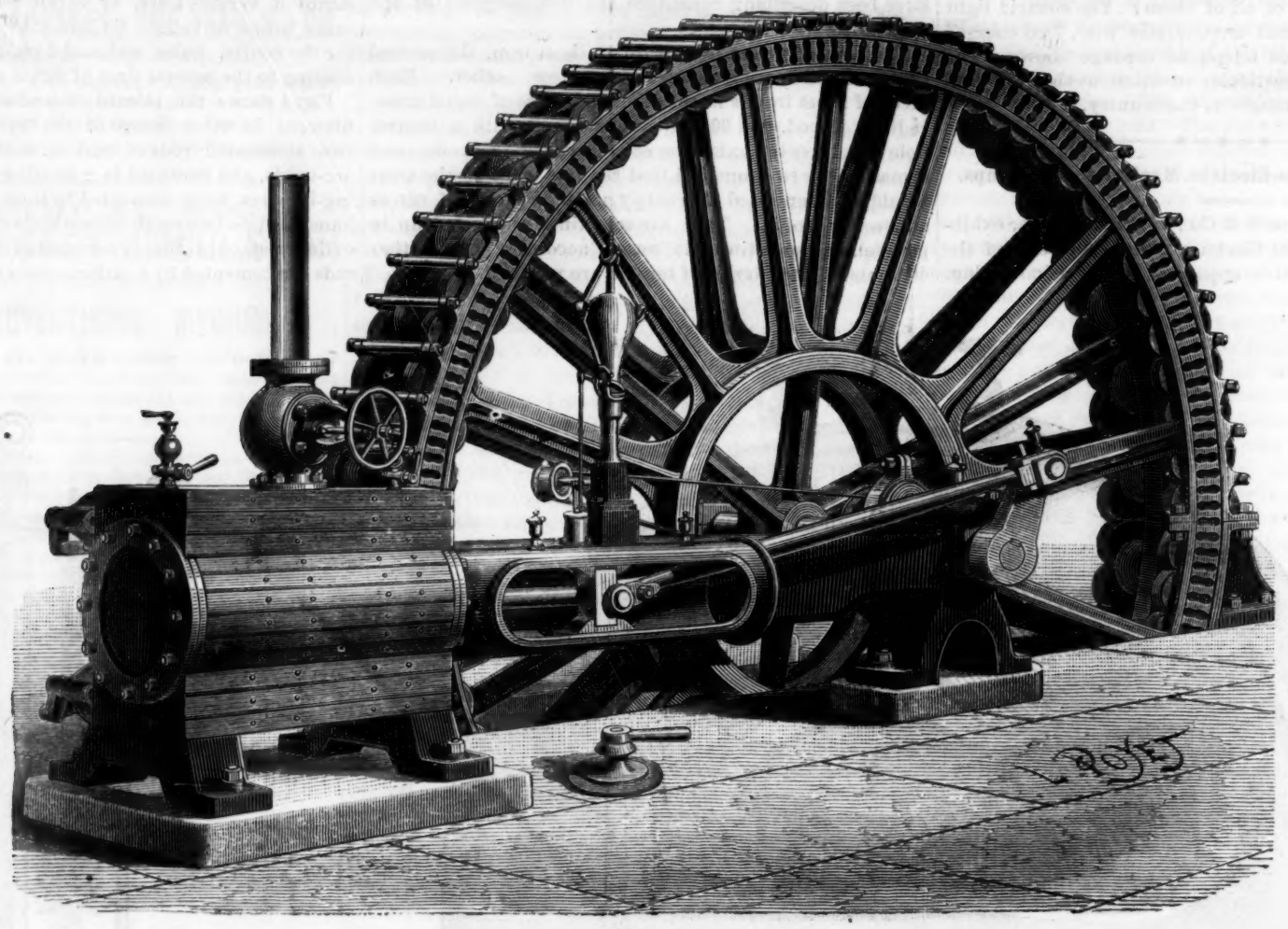


Fig. 2.

Fig. 4.

Lighting Hell Gate.

Captain Pickering, the Naval Secretary of the Lighthouse Board, states, in reference to his visit to Hallett's Point, Hell Gate, to witness the turning on of the Brush electric light on the 20th: The party of official inspectors consisted of Captain Boutelle, U. S. C. S.; Captain McCann, U. S. N., member of the Lighthouse Board; Mr. Lea, of Philadelphia; General D ane, Major Heap, engineer, secretary; Lieutenant Millis, U. S. A.; Captain Davey, U. S. N., former secretary of the Board; Mr. Copeland, consulting engineer; Mr. Coffin, of New York, and myself. (A representative of The Electrical World was also invited.) We were received on board the tender John Rodgers at Jersey City by Captain George Brown, U. S. N., inspector of the district, and his assistant, Lieutenant C. H. West, U. S. N. The tender proceeded to and anchored in Morris Cove and the party landed at Hallett's Point and inspected the plant. At half past six the light was turned on and shone so brightly that the buildings on Flood Rock were distinctly seen, as were also the shores of New York and of Ward's Island.

The party next went on board the Rodgers and passed to the upper end of Ward's Island, the shore lines being clearly visible. In returning we passed on the opposite side of Mill Rock and Flood Rock, where the effect was simply grand.

In passing Blackwell's Island the shore was distinct down to more than half its length. The blinding effect complained of by sailors elsewhere is here obviated by the great height of the lamps, and the shadow complained of for the reverse reason is softened and relieved to that of ordinary lights. This is an important achievement and the Hell Gate light was pronounced a perfect success. The superiority of the Wigham gas lamp over those of mineral oil is only as 220 is to 190, the excess being due to the use of five burners instead of four, while the maximum luminous power of electric light through lighthouse lenses is 3,000,000 candle units.

Fig. 3.

Fig. 6.

The new Boulton Carbon Works, at Cleveland, O., will, in all probability, be finished before the end of the year.

Long Distance Telephoning.—A series of experiments have been made between the Liverpool and Manchester offices of the Lancashire and Cheshire Telephonic Exchange Company, Limited, with the object of testing the practicability of sending telephonic messages a distance of 297 miles. The company has now its own wires laid from Liverpool to Manchester, via St. Helens, Wigan and Bolton; and by a method of looping the nine wires which already run to Bolton, the distance mentioned was arrived at. The result of the experiments was said to be highly satisfactory.

National Conference of Electricians.

FIFTH DAY—SEPT. 12, 1884.

The discussion on secondary batteries was continued as follows:

Prof. Charles H. Koyle: Mr. President, I should like to say something in reference to the theory of the secondary battery. For a long time we have had secondary batteries of some sort or other. It is to Planté we owe our knowledge that there are no two substances which, placed in juxtaposition in a secondary battery, will give the electromotive force that peroxide of lead and spongy lead of the Planté cell will do. It remains the same as it was in 1859, when Planté experimented and wrote. It therefore follows that a battery with these two substances will exceed batteries with other substances in efficiency, because a battery of high electromotive force is better than one of low electromotive force. Batteries of low electromotive force are not exactly useless, but the next thing to it. Peroxide of lead and spongy metallic lead we may take as two substances which should be used in secondary batteries. The simple case is to use masses of these substances, with wires down in them; but we are met instantly by the fact that the resistance is so high we cannot use them; so that we must use some form of plate so that the resistance may be low.

Now, then, when we come to the work of the plate, our battery must be a box of some sort, with two plates in it. For a simple case, the one coated with oxide of lead, and the other with spongy lead have their surfaces in direct contact with the liquid containing sulphuric acid. The necessities of the plate, then, are the only difficulties to be considered. They are three, and they are very simple ones. The plate, first, must be a conductor of electricity, and that leaves us the metals and carbon; no others, I believe.

The plate, in the second place, must resist the ordinary chemical action of sulphuric acid. That leaves us lead, four or five expensive metals (platinum, gold and so on) and carbon.

Our list is very much reduced because we have practically for this purpose only lead and carbon, the expense of the other metals being too great to allow them to be used extensively for commercial purposes.

Now we come to our third and last condition, and that is that the plate must resist both the electrolytic action and the oxidizing action of the current. Lead will resist the electrolytic action of the current moderately well. But the oxidizing action reduces the lead to an oxide in a very short time. That leaves us only carbon for the secondary battery of the future. I think there is no way of controverting that argument. I should be very glad to know if there is.

Now, then, to the manufacture of the carbon plate. The capacity of the storage battery depends entirely upon the amount of lead and peroxide of lead which you can put upon these plates. They are the substances in which the chemical action takes place, and the quantity of which you can put on the plates determines the capacity of your secondary battery.

It is possible to take carbon, and to manufacture carbon plates by the ordinary method. Take ground charcoal, ground gas carbon, and mix gas tar with it, or molasses, or any hydro-carbon. Mix them pretty dense and put into a press so as to give a shape to it, then put it into a closed furnace and carbonize it so as to drive off the gas and leave the carbon free. Those plates are pretty good for ordinary primary batteries. But when you make the shape of the press such that your plate contains a lot of little holes very much as the lead does now in use, the plate is very apt to disintegrate. There is such an enormous surface exposed that the action of the current is apt to disintegrate the plate and the face will scale off.

A better way to make the plate is then to be considered. There is a method of making these plates which is very much liked; a method in use by the United States Electric Lighting Co., in the manufacture of carbon for their incandescent lamps. That is, to take celluloid and put it through some chemical operation which deprives it of a part of its gum, thereby leaving a substance very easily carbonized.

That substance may be cut into the shape of plates desired. You can make some of these plates thick, and some thin, then carbonize them and you will always have good plates. It is not very strong, but it is a good plate. Another method which I myself have used I have found to work very well, and I shall have more to say about it in the course of a few months. At present I can only tell you the general method. I take gas tar. If you take coal tar, put it in a closed furnace to drive off the gas, you get rid of the ordinary illuminating gas and the heavier gas which is condensed as it passes through the tubes into coal tar. The constitution of the coal-tar depends first upon the constitution of the coal, and secondly upon the temperature at which the gas is driven off. The constitution of the coal tar differs to an enormous extent, I am almost afraid to say how much, when the temperature is changed to a very small exent then. The coal-tar is next put into a large cauldron and evaporated.

The object is to get out the lighter parts of the coal tar. Coal tar is a very composite substance. The physical qualities of coal tar vary so much according to the temperature at which the gases were originally driven off, and again according to the temperature at which evaporation is carried on, it requires months of experiments, as I have already said, before it can be determined what is needed. You have first to form a multiplication table of temperatures here and there, and make out a list of results. Then you have the same thing over again, in the evaporation process. This coal tar, when it is thus taken, evaporated and brought down to a consistency requisite, which is a matter of experience, is taken and put into a box prepared for the purpose, and put into a closed oven. The tops of these vessels are covered with sand, and one thing and another in the ordinary way to prevent the entrance of air. Then the heat is turned on, and gradually this stuff begins to boil. When it has reached a certain boiling point—and that is a matter also of experience depending upon the exact state of the tar when you put it in there. You cannot take up this evaporated mass and tell what will be its quality until it has been evaporated. Then, formulating these three things, you can tell what temperature you want to use under this tar in a boiling state. I have devised a process of quite suddenly increasing the heat. This is done by means of a double oven, one oven being heated moderately and the other to quite a high degree of heat. I had means of pushing the tar through from one oven to the other. When you suddenly increase the heat the tar no longer boils but is carbonized. Then you have the tar suddenly carbonized. You have a very large piece of this material which is carbonized just in that boiling condition. A more beautiful sample of a porous substance can hardly be found, and when I say porous I do not mean molecular pores, I mean pores the size of small peas. You then have to make your plate. I take this substance and cut it. It is true that this carbon is pretty hard, and wears out a saw rapidly in cutting it, so I have devised another method of preparing the plates of a proper size which do not need cutting. This is a process which I developed last winter. The method of manufacturing which I have described is susceptible of considerable uniformity. The character of these plates is porous, and they are of considerable value in a secondary battery. They are as permanent in an acid as glass is in a window. I think the secondary battery of the future is to be composed of two carbon plates, made something in that way. I do not assert that that is a better way than putting mechanical holes into the carbon, but it is considerably simpler and costs less. Or, the battery of the future will consist of sulphuric acid, carbon plates, spongy lead, and oxide of lead in their little holes. Planté is, of course, the great originator of secondary batteries. From a Planté cell you can get 40 per cent., and even more, if it is properly charged. A Faure battery will return, when carefully made, 90 per cent. It does not always do it, but it will return, under certain circumstances, 90 per cent. The charging of a secondary battery must be carried on just as the ordinary work of electroplating is carried on.

If you have two plates and you wish to coat one with metal (it may be silver or anything else), if you use too high an electromotive force you deposit this metal in large flakes upon the plate. It looks as though there had been a snow-storm, the flakes coming down of an enormous size, and the consequence is it peels off. If you do the plating slowly and regularly with a certain amount of current per unit of surface, which is accurately determined, you get a nice coat of the metal. So with the secondary battery, if you have two plates of a given size you will want to charge each with an E. M. F. that you may get a definite electric current per unit of surface. If you have half a dozen plates you will want to increase the force half a dozen times. That is the whole secret of charging a secondary battery made in that way. Charged with care. I think there can be no doubt but that these plates will give you all you desire in a secondary battery. As to their duration, I think they will be found good for five years.

Mr. Frank J. Sprague: With regard to the 90 per cent. of return I should like to know what parts of the circuit Mr. Koyle includes. Is it including the battery, or excluding it?

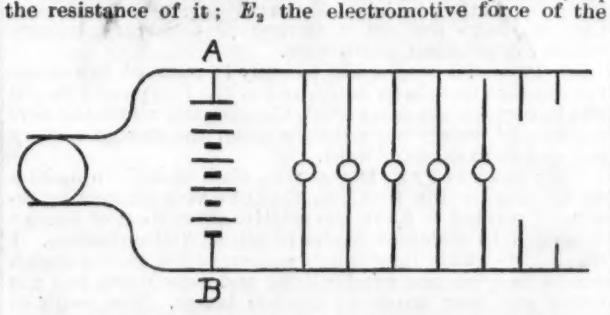
Mr. Koyle: Including the battery, of course.

Mr. Sprague: I should like to call attention to the unsteadiness of the gas engine. Mr. Preece spoke of a case in which a dynamo is put in circuit with lamps, and also with a storage battery; the effect being that the dynamo may be driven as irregularly as you please, and that the storage battery has a tendency to equalize the consequent irregularity of the current.

The only reason why it will equalize the irregularity is very much the same reason as when 1, 2, 3 or 4 dynamos are running in parallel circuit. You have a light that is perfectly steady. Just the moment the motive force in this part of the circuit diminishes, then the current in the other part of the circuit diminishes. If the force fails entirely, the current in this part becomes *nil*. If it drops still further that moment one dynamo becomes a motor. If you take your current off, that moment the gas engine speeds up and sends a current back to feed the secondary battery and the lamps. With a gas engine there is considerable difficulty in starting. I am speaking of one now of about 3 or 4 horse-power. A person has to put his foot on the fly wheel and pull it round before he can get it started. If he simply uses a secondary dynamo, he can light his gas engine, and it will start ahead all right.

Prof. Forbes: I think it best, where we have the theory complete and have no difficulty about it, to put it accurately into proper language, and then we can see exactly what we are dealing with. The action is exactly as it has been described, and I just want to show you how the equations come out, because they are very interesting in showing the regulating action of a secondary battery upon the brightness of the lights.

Let E be the electromotive force of the dynamo; R_1 the resistance of it; E_2 the electromotive force of the



secondary battery; R_2 its resistance. R_3 we will call the resistance of the electric lamps in the circuit. That will represent the resistance of the lights which come into play. Let us call the electromotive force of that point (A) e_1 and that point (B) e_2. These are the two points where all the three circuits unite, and e_1 and e_2 are the potentials at those points. Suppose that e_1 is greater than e_2, then the current circulating in each of these three circuits can be put down immediately in terms of the quantities which are there shown, involving the two unknown quantities e_1 e_2. The current which is circulating in this part of the partial circuit of the dynamo from there (indicating) up to here (indicating) always takes the direction of the current as positive when the current flows from e_1 to e_2= $\frac{e_1 - e_2 - E_1}{r_1} = C$ we may call it, r_1 being the resistance of this circuit (indicating). C_2 is obtained from C_1 by replacing E_1 and r_1 by E_2 and r_2 respectively, and similarly for C_3 (r_3 being the resistance of the lamp circuit). Finally we have the equation that the sum of all these = zero—that is to say, the total current which passes through any one point is equal to zero, which is a well-known law. We have the sum of these currents ($C_1 + C_2 + C_3$) equal to zero.

Now, in this equation, $e_1 - e_2$ is in reality the unknown quantity. It is a difference of potentials. It is the single unknown quantity of this equation. The result which we arrive at on working out this equation is that $e_1 - e_2 = \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2}$. Now this is a very useful formula and probably is well known. It is an exceedingly useful one, and has important applications here. The application especially is to finding the current which flows through the lamp circuit. The current C_3, which is the current flowing through the lamps, is equal to $\frac{E_1 r_2 + E_2 r_1}{r_3 (r_1 + r_2)}$, that is the final value of the current which is passing through the resistance of the lamp circuit.

Now, here is a remarkable thing to which attention has been drawn, and which has been commented upon by Mr. Sprague, that in this case, however much the irregularity of this dynamo machine may be, the current is found to be very steady in the lamp circuit when we use the secondary battery in that condition.

The reason of that is the secondary batteries which we are in the habit of using have an extremely small resistance, and, whenever we use secondary batteries, you will understand that we use an infinitesimally small resistance compared with the resistance of the battery or the resistance of any such lamp circuit.

If, then, we take the resistance of the secondary battery to be zero, our equation simply gives us, $C_3 = \frac{E_2}{r_3}$, with the other quantities cut out; that is to say, the current is exactly the same as if this dynamo was not working at all, and as if we had a battery of infinitesimal resistance, with this electromotive force of E_2 working through these series of lamp circuits. (Applause.)

As I am up, I may as well make a few remarks upon another point in connection with these secondary batteries. And of course the great difficulties we have had in the past times were, in the first place, that the plates buckled. This has been the most serious objection that we have had.

It is very satisfactory to hear from Mr. Preece that he found that he practically gets over the buckling of the Faure-Sellon-Volckmar battery. The force generated in these plates tending to buckling is something enormous. I do not think any ordinary separator of material which he speaks of would be sufficient to prevent the buckling of a Faure-Volckmar accumulator, for the force generated in these plates tending to buckle them is something enormous, and no ordinary separator would be able to resist this. If such resistance was offered to them I expect they would break. The reason why he has succeeded in getting rid of this buckling is because he has reverted to what is evidently the most scientific, and which will ultimately be found to be the most practicable form, that is the old Planté battery. The objection to the Faure-Sellon-Volckmar cell was not only the perfect symmetry in the plates tending to make them buckle, but also want of homogeneity in the symmetrical planes on the surface, which tended to induce local action. And that is the one great defect which has been pointed out some time ago, and which I think most people recognize now in all these batteries. In these batteries, also, the minium we used to put on would tumble off, and no satisfactory means has been devised to cause it to adhere. The question of the short life which has been attributed to them is important. I wish Mr. Preece could give us some further information about the length of life of these cells, because although he is willing to use them in his charming house, even though they last only four months, it is not everybody who will. We would like to have some more definite information, and I think there must be some gentlemen here who can give us more information about the life of these batteries. As a matter of fact, the larger form of Planté battery, the improved type of batteries which I believe are treated with nitric acid in order to render them more powerful, had been largely used of late or only within the last year or two; and, therefore, their absolute life not determined. I believe it is perfectly conceded that the life of these Planté batteries, as they have been prepared with lead, and as Mr. Preece has them in his own establishment, are the longest lived batteries, far longer lived than any artificial batteries such as the Faure-Sellon-Volckmar. I can only, in concluding, bear testimony to the charm of Prof. Preece's house in which he lives. The luxury in which he lives is most disgraceful in a servant of the government.

Mr. Preece: I hope you will confine your word "luxury" to the light only.

Mr. Forbes: To light? Before this light everything else pales. And the value of it is something, not only from a health point of view, but from the genial temper which you will see reflected in his countenance, after several weeks absence from England—is something, without joking, so enormous that really I hope, not being able to introduce it myself, that all my friends will take a lesson from Mr. Preece and introduce the system. (Applause.)

Mr. Vandyke: Mr. President, I do hope that people will not be discouraged in working in the line of other batteries besides the lead one. I think there are cases in which a battery is sure to have a long life, and sure to keep itself charged without loss to a great length of time.

There are many uses for such a battery as that, and my own work satisfies me that the zinc, alkali, and copper battery will fill a considerable want. As, for instance, in running the magnetic apparatus in observatories and work of that kind. I have made a small battery of that kind, using a spiral of copper above and putting amalgamated zinc below so as to avoid the falling down of the deposit of zinc upon the copper, thereby amalgamating the copper, and rendering it far less efficient. Although the electromotive force is only 97 or 98 hundredths of a volt, still we found by actual trial that charging the battery, taking the readings at the time, and then letting it stand for two or three months, there was not enough difference in the readings to show the slightest loss; the battery retained its charge, so far as we could find out by the means at our command, perfectly for two months, which I think is a good showing. I was anticipated in reference to using zinc and oxide of copper in the public statement that was made that there was no action of the alkali upon the oxide of copper. Still I was delighted to find the oxide formed in the oxide of copper was impervious to the action of alkali. The only difficulty which I found in using a battery was a rather curious one—that you had to be very particular about the electromotive force to be used in charging it.

I have not finished my experiments so as to state precisely the electromotive force, but it is somewhere between a Daniel and a Grove. If you charge a cell of that kind with a Grove cell and continue it you will find that the copper strip will be altogether dissolved by the alkaline

solution, forming the cuprate of soda or potash, according to the alkali used. Then that breaks up in forming the oxide of copper.

But if you are particular about not running beyond the Daniel, there is no such difficulty experienced. Taking hydrate of soda, pure electrolytic copper and zinc deposited in mercury so as to be kept pure, I found it was not due to any salt (sulphate of soda, or anything of that sort), of the alkali used. In experimenting I found further that you could use a double amount of chloride of sodium, or *ad lib.*, so as to bring down the resistance of the cell. I am by no means satisfied that even with low electromotive force, there would be much resistance for a small cell. The resistance would evidently be reduced very low indeed, and such a cell as that could be maintained, so far as I can see, indefinitely. The one precaution that is necessary to be taken is merely to throw a heavy mantle over the top to shut out the air.

I want to say a word on the carbon question. I am interested to know whether anybody has succeeded in producing oxygen on carbon to any considerable extent without disintegrating it. I have had great difficulty in that way in my experiments with the secondary battery in using a carbon plate and trying to deposit oxide of lead upon it electrolytically. I have found it would lead to the disintegration of the carbon by means of the oxygen. Hydrogen does not do it at all. Suppose you place a carbon disc in place of a platinum disc in an ordinary voltaic battery; you will soon discover how long that carbon will last. The oxygen seems to have the power of accumulating in the pores and crowding out the carbon more than the hydrogen does. I think that this matter of the copper battery is worthy of passing mention, because I can see those cases rise in which we should like to have a battery that we could charge and know we could depend upon even after several months not to lose its charge.

I am positive that anybody who tries it would be pleased with the properties of the copper battery made in the usual way with amalgamated zinc and alkali, either soda or potash.

Preference may be given to soda, on account of its being so much cheaper. The method should be to use plenty of chloride of sodium in it.

I think the tendency of the copper to dissolve and to break up into cuprate was not any greater when the soda was used.

Mr. Koyle: I just wish to inquire of Prof. Vandyke how his carbon is made, as that makes considerable difference. If they are formed by the ordinary method out of coal tar carbonized, they are very fragile and disintegrate in the battery. But if formed in the manner I speak of from coal tar, pure and simple, so that they seem to form a very much more homogeneous mass, there is a striking difference in the permanency of the plates.

Professor Vandyke: I will state that I use the commercial carbon simply.

Mr. Koyle: I think that there is a great deal of difference between the secondary battery composed of carbon plates and one composed of lead plates. I do not see myself the reason for such an expression of opinion, that the Planté battery is more scientific than any other batteries, a Faure-Sellon-Volckmar battery, for instance. It is easy to construct a Faure battery that will last forever, if you only make the plates large enough. But the battery is going to continue disintegrating from day to day. Lead has some weight, as is well known, and when you are going to make a Planté battery of sufficient size to last any length of time you will make a secondary battery of enormous weight. For any other purpose than putting down in a cellar to let it stay there, the weight is a great factor. I think that a battery composed of lead plates a foot square, the ordinary size, will weigh something like sixty pounds. I do not guarantee that exactly, but I believe it is in the neighborhood of sixty pounds. A square of carbon plate of the same size weighs about three-quarters of a pound. Now, a battery made of eleven plates of this size gives you something like 60 or 70 pounds. If you want to use electromotive force of 100 volts, as in some cases you do, it would require fifty of these cells, of 60 pounds each, which would give you about 3,000 pounds, and that outside of the weight of the electrolyte and the box. Carbon plates will make a difference of about 80 per cent. Instead of 3,000 pounds it will be about 600 pounds all told, and the carbon plates have the advantage of always remaining intact; they will not disintegrate, and will remain permanent so long as the box will or anything else about it.

Mr. Elihu Thomson: I should like to have a method which will tell whether the plates will disintegrate or not. Look on the plates that receive the deposition of peroxide of lead. Suppose we were to locate one particle of oxide which has been formed from the surface of the lead, what will be the electro-chemical conditions of that particle? Evidently the peroxide itself is in an electro-negative condition, far more so than the lead. Consequently it will set up a local circuit and distribute its oxygen more or less to the surrounding lead and thereby eat into the lead, deeper and deeper, destroying the life of the battery in time. It would seem from this consideration alone that the lead battery is certainly limited in its life.

Let us take the case of the carbon plates. Has it yet been proved that carbon is stable in the presence of peroxide of lead in contact?

Perhaps this may disintegrate the carbon and oxidize it into oxide of carbon and at the same time reduce the peroxide of lead to the protoxide of lead (PbO).

We have these two different substances, one highly electro-negative and the carbon perhaps may be inert, but then though it may be different in an electromotive force ever so slightly, we will have a local circuit which will take oxygen from the peroxide of lead and oxidize the carbon. If we wish to make a test of that let us take a massive piece of peroxide of lead. Take a specimen of the carbon which is to be tested and attach it to the other side, putting in the circuit means of testing a feeble current. Take an electrolytic liquid, for instance sulphuric acid, and see whether we have a difference of electromotive force between those two substances. If there is no such difference then the stability of carbon in contact with the peroxide of lead will be established. It may be, also, that the states in which carbon is known to exist may control the matter to some degree. The artificial plate made of carbon, which undoubtedly must be of a porous nature, and would naturally be expected to disintegrate more readily than the plate which had been made from tar, which had been coked into a porous condition, because the tar deposits its carbon in flakes, little bubbles separating them. This is seen in the plates of carbon obtained from petroleum manufacturers, which is intended to be used in making electric light carbons. The mass appears as a solid plate below, and above it is a confused mass of broken bubbles which can be planed down to show cavities of various sizes, the cavities being smaller as we approach the surface of the carbonizing vessel, which is wrought-iron.

There is another condition that might govern the condition of the carbon, and that is, we may take this carbon, and heat it to a temperature that would convert it into the graphitic variety. It is well known that if we take a stick of carbon and put a current through it of a sufficient degree to almost vaporize the carbon—in other words, to make it almost as hot as the carbon in an electric arc-light—at the extremity it undergoes a change of condition into the graphitic variety; in fact, it takes a plastic form. I have often made carbon rods as thick as a quarter of an inch in that way.

You can take this carbon and write with it as with a lead pencil. Whether it would be suitable in that form is another question.

Prof. Newcomb: Speaking of subjects that are connected with the subject of storage batteries, I wish to call your attention to some experiments made by Elihu Thomson and myself prior to 1878, in which we used two plates of copper, an electrolyte of sulphate of copper and a plate of metallic zinc. In passing in a current through them a deposit of metallic zinc was formed. We found an excellent effect was obtained in that way.

Lieut. J. E. Jewell: There is one point I have noticed that is of practical use in reference to secondary batteries, and that is as to the inequalities in the various styles of batteries. I have had an experience of 6 months with one form of storage battery, the commercial battery as it is now in use on a lamp circuit. As it is arranged it is used for lighting 40 incandescent lamps, although we have only 10 or 12 of these lamps in use at any one time. Consequently, the demand on the battery is not very great, and hence in charging the battery we find that with a 20 ampère current, instead of having to charge the battery all day, as I believe would have to be done in case the whole 40 lamps were to be used, we charge for 2 hours in the morning, or until the cells give off gas from the plates, when we consider the charging as completed. I believe after 3 weeks' use of this battery it was observed in the first place that the lamps were not up to their usual standard of power. The next morning it was found that certain of these cells, four or five of the 21 that formed the battery, were much lower in their measure of electromotive force than the other cells of the battery. It was thought, in the first place, these cells might, perhaps, have become exhausted by short circuits; but from very close examination there were revealed no short circuits in the cells, and, furthermore, when the charging current was put on again, those cells were the first of the whole battery to give evidence of being charged. In other words, it would seem as if the storage capacity—if I may use that expression with regard to those cells—the storage capacity of these particular cells had been diminished in some remarkable way.

We restored those cells by a process, the process which we were instructed to use in the first place. A battery was first set up; that is to say, by a prolonged charging of the whole body—a charging of some 20 hours with a current of 20 ampères, and then a discharging of the whole battery on a fixed resistance which was about equal to the lamp resistance, say, .8 of an ohm; then another charge of 20 hours with a 20 ampère current and again discharging the battery for 3 or 4 hours on this fixed resistance; then recharging for 20 hours. At the end of that time the battery was in good condition again, and those particular cells which we had found had given out before did not give out again for several days; but in every case, I think, where that process has been repeated three or four times, it finally takes about three weeks for these batteries to give out. I don't remember exactly now whether the same cells were involved, but I think that out of the five or six cells four have been involved every time. We occasionally find another cell going in the same way, and I think it is a question of time when all cells will probably behave in the same way. Otherwise the cells which have not given any trouble are good cells. The whole resistance of the battery is very low, and the electromotive force is very constant, with the exceptions that I mentioned, and the light is very satisfactory. But I am not at all sure that Mr. Preece has found a solution of the lighting question by means of the secondary battery. It is to be hoped that he has. My experience rather indicates that we have not got a storage or secondary battery which is a practical instrument.

Mr. Preece: I would like to reply to some of the observations that have been made, and in the first place I should like to corroborate what Prof. Carhart said about the percentage of energy we recovery from the storage battery and utilize in shape of light.

Very recently Prof. Dewar was kind enough to make a calculation for me that brought out a very interesting result. I wanted to know the relative proportion of energy expended in different modes of artificial illumination. I wanted to know how much was expended in the sperm candle to give one candle light and how much in a gas flame and how much in electric lamps. The result of Prof. Dewar's calculation was to show that in a sperm candle for one candle light we expend 97 watts. The experiment with gas showed that for every candle given out 62 watts were consumed. Now I have been experimenting with various incar descent lamps and one lamp gave a result showing that it was possible to obtain one candle for 2.5 watts. While with arc-lamp illumination, such as we use in the street, we get a candle for each watt expended, and if the arc lamps were bereft of the hideous structures put around them to destroy or reduce their light, we should probably get a candle for each half watt.

That shows the proportion of one per cent. Prof. Carhart named must be within the mark. For if we can get one candle for the expenditure of one watt, and we otherwise expend 97 watts in the process, it is clear that 96 watts must have been wasted. There is another point that arises out of this to which I want particularly to call your attention, although I am afraid I am going to promulgate a doctrine which may induce many of you to set me down as very paradoxical.

My doctrine is simply this, that I believe the days of the arc light are numbered and that all the lights in the future will be furnished by the incandescent lamps. My reason for saying that is simply this, that up to the present time in the incandescent lamp, such as we have, the light is produced by the expenditure of from 4 to 5 watts per candle. Improvements and very rapid improvements are being made in the form of the carbon filaments. We are now using lamps in England that give us light with an expenditure of only 2.5 watts per candle. If improvement goes on at this rate I am quite certain that before another decade we shall have incandescent light that will give us one candle for each watt. When that is the case then the incandescent lamp will be used in place of the arc. The arc requires constant personal supervision. It requires mechanism to keep it in order. It only lasts a short time, whereas the incandescent requires no attention whatever after it is put up, and its life is very considerable indeed. In London, lamps can now be obtained whose life is guaranteed to be a thousand hours. I believe on this side of the water they are guaranteed to a certain extent, I do not know what, but if we can get incandescent lamps giving a light at the expenditure of 1 watt per candle, and whose life will be over 1,000 hours, then it will be a case of good bye to the arc lamps.

There was one other point that I did not mention in regard to my battery and that was I am using only 17 cells. I am using only 30-volt lamps and I use them for security. First because it gives me very few cells to keep in order and secondly because the electromotive force is so low that there is not the slightest fear of shock, and consequently there is not the least fear of fire due to a short circuit or imperfect action in any of the insulating means.

In isolated houses the lower you can reduce the electromotive force, the safer it will be. It is only where the houses are isolated that the question of low electromotive force comes in.

Now, with regard to carbon, I am sorry to say that I differ altogether with the view that has been expressed that carbon is likely to replace lead for secondary batteries. Carbons do disintegrate with us in London to a very large extent in the present form of battery. The battery we principally use is a bichromate battery. In that battery the carbons do not last more than twelve months. They do disintegrate; they tumble to pieces; they become quite soft and spongy, and it is quite impossible to use any form of molded carbon—and we are obliged to use cut carbons, because the molded carbons will not last more than two or three months. While the cut carbons do not last more than twelve months the lead in the secondary batteries will last more than twelve months. I did not make the statement that the lead lasted only four months. I think it will last more than twelve months. I know of houses where the batteries have been in use more than twelve months, and I am quite satisfied that the lead used in the one I have described will have a durability of more than twelve months. I shall not be the least surprised if it lasts for two or three years.

Mr. Sprague referred to the use of the secondary battery for starting the gas engine. Now I am sorry to be obliged to say that I look upon the employment of such a battery for such a purpose as simply barbarous. (Laughter.)

I say this, because I believe that the whole, I should not say the whole but the greater portion, of the causes that have brought secondary batteries into such ill-repute are due to the various barbarous practices that have been adopted by those who have been using secondary batteries. These practices have been indulged in without the person knowing the injury they were doing to the battery. The practice has been to dash in a piece of wire in order to see the sparks, and then to say "what splendid order the battery is in." A more iniquitous or sinful practice could not be adopted. It is just like a doctor cutting off a man's head to examine his tongue. Such a practice as that has given the poor battery a straight blow between the eyes, which it will struggle with for days. Any practice that suddenly calls into action the force of the battery, such as short circuiting, is simply barbarous and tends to destroy the battery more than anything else.

I test every cell of my battery every morning, with a galvanometer of 100 ohms. The galvanometer is simply run over all the cells; it takes but a short time, and you can see exactly the condition of the cells without in any way interfering with the condition of your battery.

There is one point about which I should like to have Prof. Dewar tell us a little something. There is one defect, and it is a very peculiar defect in all of these forms of secondary batteries. It follows after a short time after covering the plate with minium, and it is the formation of trees on the plates, bringing the plates in contact. That formation is observable in that form and type of battery, and it is not observed with the Planté. Planté himself has never suffered from the formation of trees, nor have I in the batteries I am using seen the slightest sign of these trees. Therefore, I think that the mode of separating to prevent buckling in my case will be a cure. Such a grate as I use would not prevent treeing, and therefore it will not cure that defect, which is one of the most serious defects of the Faure battery.

I mentioned while I was speaking first that there had been a good many untruths expressed about secondary batteries, but the untruths about secondary batteries are as nothing compared with the untruths about primary batteries. Such a battery as we have described to-day has been brought before the London public, and it has been stated that the products of the battery formed in its action will repay the cost of the battery, and that the products can be sold for more than they cost. Therefore it has been suggested, if that is true, what a splendid thing it would be for the government to buy up all these batteries to use them, and in that way pay off the national debt.

A great many experiments have been made and the results of these experiments are not to be discarded. They are useful for certain purposes, but they are not just yet going to knock out of the field secondary batteries in the way that has been described before us.

The inequalities to which Lieut. Jewell referred are due to the impurities of the liquid. I have suffered somewhat in the same way. I have cured it precisely in the same way by putting on the power for twenty hours and in that way the impurities, or whatever they may be, have been worked out. The result has been that after doing that twice I have had no difficulty for the last two months.

What I am going to do is this. I am going to have my battery in such order that my gas engine by going one day all day long will charge up my battery sufficiently to enable me to keep my house lighted for the rest of the week. (Applause.)

Prof. James Dewar: My view with respect to secondary batteries so far as I have been able to look into the question from the chemist's side is about this. I feel that in the future some other body than peroxide of lead will be discovered, which, I trust, will more efficiently represent the amount of energy absorbed. I take it to be that after all it is a question of relative efficiency of the agents which have been used, we may say, disassociated by the electrolytic action.

It seems to me that apart altogether from the difficulties of conduction, and the question of local action, that the question is whether there are any other bodies likely to be formed, or is it not conceivable that possibly the large class of bodies which can be formed will be as efficient, provided we arrange a definite local action, as we must, to a large extent, in other cases.

Let us take the case, then, of the types of these bodies. We know that in ordinary cases of decomposition, even of the simplest kind, that we have two actions taking place. Take the case of the formation of chlorate of potash: $2(KHO + Cl_2) = KCl + KOCl_3$. Now, as a matter of fact, we have an exothermic and an endothermic action taking place side by side. This action takes place like a majority of chemical actions with a considerable evolution of heat; but the evolution of heat is, in this case, due to the formation of the chlorate of potassium and not to the formation of the chloride. The chlorate itself would be endothermic, or would be minus, or there would be a reduction of the temperature. Therefore the energy for the formation of the chloride is really in some miraculous way extracted out of the energy produced by the direct formation of the chlorate of potassium. Now, this is the kind of body—something like this body—that we want in electrolytic action. We have, by the electrolysis of the water, peroxide of hydrogen with the chlorate of potash. Peroxide of hydrogen occupies the same place that the chloride of potassium does in the reaction. In the case of the electrolysis of muriatic acid hypochlorous acid occupies the same position; it is endothermically formed with a considerable absorption of energy, and consequently can decompose into hypochlorous acid again with the evolution of heat. The same is the case with the peroxide of hydrogen.

If we replace chlorine by iodine we find in the ordinary form an iodide and iodate. There is, if anything, a slight reduction of temperature. That is because the iodide is positive and the iodate is also positive, and this is so much weaker that it would be impossible to form iodate if iodide had been formed by the absorption of energy. If we could construct a battery in which all the oxygen is fixed in this way to an unstable body, there is no question but that we could produce a much higher electromotive force. If we take the case of electrolysis of salts we know very well that in a great majority of salts the electromotive force is practically constant. That accords with the well-known fact that the thermal value of the majority of soluble salts is nearly independent of both the acid and the base. That is to say, it is nearly constant, giving us something like fifteen thousand gramme units. Some a little higher, but that is not the case with weaker acids. We may say, therefore, if we construct a battery of soluble oxide and soluble acid that the electromotive force is practically constant, because the thermal value is practically constant. If we wish to get a higher electromotive force we must produce a form of this type. Take peroxide of manganese hypochlorous acid, or peroxide of lead. Therefore the question comes to me as to how we may include chromates, chromic acid being some way available, or at least one-third of the oxygen, for this very purpose. Now I take it that the chemistry of this lead battery is not by any means cleared up.

It would seem in the electrolysis of water that you can hardly detect the peroxide of hydrogen. It would seem that the reactions that the chemists have mistaken for peroxide of hydrogen reactions are really reactions which do not belong to it at all as obtained from the electrolysis of water with platinum electrodes, but are obtained from electrolysis of persulphuric acid (SO_4) or some variety of sulphuric acid which is improperly distinguished.

That being the case, therefore, we have to consider cases where we can have converse reactions easily. A type of that kind would be of this order, as in the case of iodides. We take iodic acids, that may be easily formed by the oxidation of hydriodic acid. If we have iodine we may very easily, in the presence of hydrogen especially, get hydriodic acid. Hydriodic acid may be formed from nascent hydrogen and iodine. Only in this case there is undoubtedly a considerable dissipation of energy, because it is not like chlorate, this change taking place with a considerable evolution of heat. I presume that change takes place the moment you mix the hydriodic acid with the iodic acid. It is reactions of that type that we require. For the same water and iodine here you have the hydriodic acid and iodine, and they come back to water and iodine again without any possible derangement. Therefore, it is to the question of getting reactions of this kind without dissipation of energy that I look in the future to further advance in the construction of secondary batteries.

With reference to one or two points that have cropped out, such as the disintegration of carbon. The same thing is remarkably apparent in compressed graphite even when produced by great hydraulic pressure, and when perfectly pure. If it is used for the poles of the battery in ordinary electrolysis, it degenerates with the most extraordinary rapidity. I believe it is largely due to the mechanical action of gases of the battery on the graphite. The carbon does disintegrate, and the chemical compounds formed seemed to be of the same type as if they were produced at a high temperature. The chemical product seems to be what is called mellitic acid. It has carbon added to it, as it were, with 6 of carbonic anhydride $C(CO_2)_6$. It is of the same type as benzole. In fact it breaks up into carbonic anhydride and then we have benzole produced. That body is called mellitic acid.

The result of the electrolysis is ultimately mellitic acid and gases of carbonic anhydride and benzole—benzole being the body which is produced when hydrogen in the presence of the electric discharge is produced at a high temperature. With reference to Mr. Preece's remarks in regard to the efficiency of the incandescent light, although it has nothing special to do with secondary batteries, except in their application, it is quite clear that, if what he says is true, and I do not doubt it for a moment, he must be working with an incandescent filament at a very much higher temperature than is customary with the incandescent filament.

If you do not reach the point of destruction of the carbon there is no reason why the efficiency of the incandescent lamp should not be as great as that of the arc. It if not the efficiency of the gas, but of the solid pole at the same temperature. I say there is no reason why the incandescent should not be of the same efficiency as the arc. I do not see anything more in that but what may be of use in this. Some years ago I made a series of experiments as to the increase of the amount of luminous intensity with temperature. I used platinum, but within a considerable range; and since that time the experiments have been followed by others in the same line, and all seem to prove that this is an average and fair way of representing the results, and sufficient, I believe, in the meantime for practical purposes, that if you take a temperature above 500 degrees—of course I take 500 degrees as representing the temperature at which light begins to be emitted—then you may say that as the result of all the experiments that the mean rate of increase of luminous intensity is as the sixth power of that temperature.

Therefore you may say the luminous intensity of a solid is as a sixth power of the temperature above 500 degrees. There is no reason at all why this temperature of 500 degrees is not the point from which to consider the rate of increase of luminosity. Of course we must take that temperature because our vision is imperfect. It is exactly the same thing as we find in cases of the relation of fluid volume. Temperature is simply represented by taking the temperature of the melting point in each case, so there is no reason to say that this temperature which represents the temperature at which the light begins to be luminous should not be the point at which we should consider the temperature in this case. Therefore, in the sixth power of the temperature measuring over 500 degrees, you have a measure of the increase of luminous intensity and that very fairly represents my own results, and also the experiments of others. This formula enables us to give the temperature of the incandescent filament, and there can be no doubt that the explanation of the efficiency when you work with higher temperatures is simple this—that you work with higher temperature. When you look into the matter, the greater the degree the greater the refrangibility. This is a point of some interest. I still think that there are a great many points in connection with the chemical side of the battery which we have been discussing which we are not in a position really to answer; but sufficient, I think, has been said to point to the direction in which we ought to work.

Mr. Keith: I would like to ask Prof. Dewar whether he has investigated, either theoretically or practically, the decomposition and recomposition of the sub-salts of lead, such as were the subject of discussion some time ago. I think he was not present at the time when I stated my own experiments in that line.

Mr. Dewar: No. I regret to say that I have not.

Mr. Keith: Taking the solution known as Goulard's solutions of sub-salts of lead, which are all very soluble, the peroxide and metal are readily formed and dissolved and redissolved in the solution under electrolytic action. So far I have carried them into practical effect only in the laboratory, but I have found that all the electricity is returned as electricity, but of course all the energy applied is not returned.

Prof. Dewar: The only experiments I have made in that connection are of the same type as many others, namely, that if you take an ordinarily compressed block of pure sulphate of lead, place it on a platinum electrode, and if you electrolyze that, and electrolyze it for hours, you will only succeed in getting a very small quantity of peroxide of lead. As I understand it, the fundamental action is admitted to be that the peroxide of lead is really produced from the sulphate; I do not say it is not produced from the sulphate; all I say is, that if you take a compressed block of sulphate of lead on a platinum plate, and if it is electrolyzed for hours, you will get a small deposit of peroxide of lead.

Mr. Keith: I think the gentleman misunderstood my question. I want to state here that from solutions of subacetate of lead there is by electrolytic action deposited upon one pole peroxide of lead and metallic lead is deposited on the other pole.

Reversal of the current in discharge reverses the operation; both peroxide of lead and lead are dissolved.

There is a difference of potentials, say, of one and seventy-hundredths volts.

The conference then adjourned until 3 o'clock P. M.

On resuming at 3 P. M.:

The President: The next business in order is a continuation of the discussion on storage batteries.

Lieut. Jewell: I would like to say a few words on this subject, and I would like to point out some of the defects in storage batteries of the Faure form. In regard to lead building across between the plates, I found that thing quite a common experience some three years ago when I experimented with them, and I was rather sat on when I called attention to these experiments and to these facts at the meeting of the British Association at Montreal. But I believe that the same thing had been found by Gladstone and Tribe, although I think that they did not find it themselves, but said in their papers they had seen it referred to. The cells to which I referred were not Faure cells. They were cells of the Planté type, but of a peculiar construction. The lead plates were of a peculiar form, and were entirely separated from each other. They were separated also by pieces of paraffined wood to prevent buckling. Now, with regard to whether it was the impurities of the cell or not, I am not inclined to agree with Mr. Preece on that point—the impurities of the lead. I should say the lead, in the first place, was clean. I have no doubt but they are as absolutely pure as lead could be obtained. Beyond that they were so placed that if the lead was not pure lead any local action that would take place in the cell on account of the impurities of the material would not affect the electromotive force of the cell; it would cause a waste of the material, but no other effect, and would not affect the resistance of the battery nor its electromotive force.

I attribute this action to the formation of some non-conducting film over the surface of the plates, both the peroxidized plate and the metallic lead plate. There is no doubt that the oxide of lead, in the particular form in which we find it in the secondary battery, is attacked by sulphuric acid, with the formation of sulphate of lead. We all know that sulphate of lead is a pretty fair insulator. The fact that the cell is restored after prolonged charging, during which, of course, there must be a great loss of energy, and the fact that they are restored to their original condition, induces me to believe that it is not impurity in the lead, but rather to the non-conducting film which covers the plate. Besides that, there is no short circuiting in the cell. I am quite satisfied, from attendant circumstances and from observations during experiments that were made, that there was no short circuiting in the cells.

Before I leave this subject I would like to say a word or two with regard to the hope that Mr. Preece indulged in. I am glad that he has had such an encouraging experience with storage batteries. I am inclined to think he will be disappointed in the hope expressed of being able to charge the cells on one day of the week and then use them during the rest of the week.

A very simple calculation would convince him, as well as the Conference, that such a plan is not practicable with his present plant. Perhaps, if he increases his plant, he may be able to do it. He cannot do it with that which he has on hand. If we take the figures as Mr. Preece has given us of one candle from 2½ watts of energy, then a 16 candle lamp requires 40 watts, or an efficiency of about 18.6—16 candle lamps per horse-power of electric energy. This, I must say, in the first place, is a little high. Forty watts with 30 volts difference of potential between its terminals gives us 1.3 ampères as the current to each lamp. Now, if we assume that Mr. Preece has, we will say, 10 lamps—put the number small, because 10 lamps are enough for ordinary use—10 lamps will require 13 ampères to maintain them. Thirteen ampères for three hours are 39 ampère hours. I use the term ampère-hours simply to avoid converting the quantity of electricity into coulombs. Thirty-nine ampère-hours, on an average night, for 7 nights in the week, are 273 ampère-hours. Now, divide 273 by the efficiency of the storage batteries, 40 per cent., and we get as the total number of ampère-hours during which the battery must be charged, 682½. If we divide that by the number of hours during which the charging will take place, 12 hours during the day, that will give us the current to be used in charging the storage battery to produce this result; we obtain 56.9 ampères at 42 volts, or say, according to Mr. Preece's statement, 52 ampères to .8 of an ohm. The charging resistance of the battery would certainly be greater than .8 of an ohm. I call the charging resistance of the battery the difference of tension between the terminals of the battery while the battery is being charged. That is what I designate by the term "charging resistance." The charging resistance, I am sure, from my own experiments cannot be less than 2 ohms, if we shall be allowed to call them ohms.

Consequently the current of his machine will be very materially reduced. Besides that, admitting that he could get this current of nearly 57 ampères, which he requires for charging the battery, the question is how long his cells will stand a current of that magnitude. I am inclined to think that a very few weeks charging with a current so great as that will very soon use up his cells.

Mr. Preece: It is a dangerous thing to tackle figures; you can always make them prove anything you like. The assumption he starts with is wrong, for I am only using 10 candle lamps, and they absorb $\frac{8}{10}$ of an ampère. I cannot go through with the calculation here, of course. But my experience shows that I can get 200 ampère-hours out of my battery, so I shall have enough to last me a whole week; and the batteries, I am quite sure, after they have been used a little time, will give me that and a margin to spare. I am quite certain, notwithstanding those figures, that if I have the pleasure of coming over here again, I shall be able to report that from one day's charging I have had my light for a week.

I will mention one fact, which I neglected to mention to you this morning. At the time my gardener cut off the toes of his foot, my battery had been charged up Friday morning. I had a dinner party Friday night, and, whenever we have dinner parties, we make all the show we can. On Saturday I had no dinner party, and I used my lamps as usual; on Sunday I used my lights as usual; on Monday morning my man cut off his toe; I had a dinner party on Monday night, and I did not know of the accident until I got down just in time to dress for dinner. Without saying a word to anybody I trusted to my battery, and I found it held on for the whole of that night. I had, without any further attention to the battery as it stood, sufficient light for two dinner parties and four days.

And I think that, as we did that in an emergency, with a little gentle care that can easily be given, I am not far wrong in saying that I shall be able to have enough for a week's use.

Mr. Koyle: I would like to say one word. I am afraid the public at large will think we have had a dinner party from some of the statements we have been trying to make. I would like to put on the board some more figures, even though they are dangerous.

I believe Mr. Preece said that in England the result he obtained by the use of gas was, that it took 62 watts to furnish one candle power and it took 2.5 for an arc lamp. Some calculations made two or three months ago, made me wonder at this. The calculation will take but a moment. I think that the result arrived at is entirely erroneous, and for the sake of the public at large, who, thinking because we are assembled as an electrical conference, we are talking very high, I would like to present it. One ton of coal will furnish at the most 30,000 cubic feet of gas.

Mr. Preece: Excuse me, I think you are wrong in your first figures. A ton of coal produces 10,000 instead of 30,000.

Professor Rowland: I suppose that the 62 watts and the 2.5 are in the terms of heat. In the transformation of the original heat through the steam engine there is a loss of all but 10 or 12 per cent. I do not think there is any necessity of making the calculation, for one is in terms of heat before it is transformed.

Mr. Koyle: I think it quite likely that is correct.

Mr. Sprague: I wish to make one correction in the statement of Mr. Preece. He accused me of a barbarous practice in starting a gas engine by closing the short circuit of a storage battery. I referred to something which happened in a private house without my advising it to be done. On the contrary, I do not believe in storage batteries and I am not a friend of storage batteries and do not recommend their adoption. I would suggest to a person who is going to start a motor in that way that it is easy to shut down to one and five-tenths volts of a storage battery. It would be a better practice to introduce a resistance in the circuit of that battery so that in passing the current through the dynamo no current can possibly pass through that would damage the battery. There would be very much less current. To any one who had the trials and troubles of starting a gas engine of from 2 to 40 horse-power, I think that they will agree with me that if by electrical or mechanical means we can start the gas engine, say, by sending part of our current back through a motor without damaging the battery in any way, we have a great boon. Any practical electrician will agree that it is better than expending 10 to 20 minutes in trying to get the gas engine started by purely muscular effort.

Mr. Preece: Let me remark, that now all gas engines are fitted with self-starters; every gas engine I have seen has an extremely simple mechanism called a self-starter, by which a child can start the engine by pressing the tap of an ingenious device by which a cylinder buried underground is put in operation. This cylinder takes a mixed charge of gas and air under pressure of about 100 pounds and by the slightest movement of a tap sufficient power is

developed by an explosion in the gas chamber to immediately set the gas engine in motion; so there is no need of using secondary batteries, nor any other means of starting.

Mr. Sprague: I spoke of what had been done. At the time I spoke of, no self-starters had been used. Mr. Schlumm, who was making the Otto gas engine, had not then made a self-starter. I do not think there is any gas engine in the United States that has this self-starter. Of course if anybody has a self-starter he can use it.

Professor Forbes: I only want to ask if there is any one here who will tell us more about the testing of secondary batteries. It is a point upon which I have sought to hear some remarks. I have already spoken, and I do not like to speak upon this subject again. I hope somebody will make some remarks about testing secondary batteries. In my own opinion no test has ever been made as to the efficiency of the secondary which was a scientific test. In order to have the test efficient, you must know what you put in and what you get out. You must leave the battery in exactly the same condition electrically as it was when you started with it. I believe these conditions have never been fulfilled. I do not think that a single efficient test of a secondary battery has been made.

Case's Electrolytic Fluid for Secondary or Storage Batteries.

In secondary batteries, as in fact in all batteries, it is desirable to have the two electrodes as widely apart in electro-chemical character as possible. In Planté, as well as in other secondary batteries, the peroxide of lead formed on one plate during the operation of charging the battery is of the highest electronegative character, but the metallic lead on the other plate is not of the most electropositive material. Zinc is much more electropositive than lead, and its use has been proposed as the positive plate in place of lead.

It has been so used; but because the electrolyte attacked it the experimental practice came to be to amalgamate it, as in primary batteries. Under action of the battery, zinc was dissolved and the peroxide of lead was reduced to metallic lead. But as soon as this was accomplished the two electrodes were but zinc and lead, and their difference in electromotive force was but slight.

When current from another source was applied, as in the operation of charging, the zinc failed to be again deposited—nothing but hydrogen in place of zinc. The hydrogen escaped to the air, was lost, and represented an equivalent loss in the energy applied. Zinc cannot be deposited from its sulphuric acid solution when an excess of acid is present.

This excess of acid comes even with a solution neutral at the start, after the deposit from it of a small quantity of zinc. If the plate to which oxygen goes is of zinc, it is dissolved in equivalent quantity to the zinc which is deposited. But this is a simple electrolytic cell in which, as the analysis and synthesis is equal and opposite, no energy is absorbed other than that required to overcome the resistance of the cell.

It is necessary in secondary batteries to have the oxygen, freed by the charging currents, absorbed by the metal without forming a soluble oxide. And it is also necessary to have the hydrogen which is freed act to combine with the oxygen of the metal, the oxide of which is either in solution in the electrolyte or is present on the other plate to be there acted upon. Peroxide of lead and zinc pairs satisfy these two latter requisites, so that it only remains to provide an electrolyte which will remain neutral as to acidity that it may not attack the zinc except under the conditions of use as a storage battery.

As deposition of zinc would make the electrolyte acid in a very short time, and thus defeat the desired object, it remains, as a remedy, to substitute some other material for the displaced zinc.

Recognizing the facts set forth in the preceding statement, Mr. Willard E. Case, of Auburn, N. Y., makes an electrolyte composed of solution of zinc sulphate to which enough magnesium oxide is added to absorb the equivalent of acid set free by the charging current in depositing zinc. The magnesium sulphate so formed is neutral, and does not attack the zinc during the idle periods of the battery.

This electrolytic liquid was patented in the United States, Sept. 30, 1884, and was noticed in brief in the Patent Record of our last issue. Lack of space prevented a more extended notice at the time.

The Mackay-Bennett Cable.

The final splice has been made, and the two Mackay-Bennett ocean cables connecting the New with the Old World have been successfully laid by the "Faraday." Mr. Brittle, the chief electrical engineer of that ship, sent a dispatch to Mr. George C. Ward, the manager of the Commercial Cable Company, at noon on Wednesday, the 22d. It contained the welcome news that the "Faraday" had reached the buoy and that the final splice was about to be made. Communications were exchanged between Coney Island and Canso, N. S.

The new cable repairing steamer "Mackay-Bennett," which was launched recently at Glasgow, is being fitted out with dispatch, in order to be able for any possible emergency. The cable line which is to be laid between Havre, France, and Waterville, Ireland, has been manufactured and is only waiting the return of the "Faraday" to lay it. A line between Havre and the offices of the Commercial Cable Company at Paris has been secured, so it will be seen that every department of the work is being actively pushed forward, and the lines will soon be ready to receive the messages of the public.

The "Faraday" will sail from Halifax in the course of a few days. She will repair the break in the Mackay-Bennett cable on the Banks of Newfoundland, and when that is done the two great ocean cables will be in perfect running order.

Chemistry of the Carbon Filament.*

BY EDWARD P. THOMPSON.

The object of this paper is to treat the manufacture of the carbon filament from a chemical point of view, pointing out the chemicals from which they are or may be made; the chemical actions which take place according to principle or experiment, or both; and the conditions which are necessary in order to obtain a filament of the maximum density, hardness, elasticity and homogeneity.

The principal lamps now being largely manufactured and represented at the Exhibition, and in which the filaments differ from one another by distinct chemical reactions which take place in their manufacture, are the Edison, the Swan, the Weston and the Stanley and Thompson lamp.

The Maxim lamp falls under the Swan and Edison in this classification, being distinguished from them only in the hydro-carbon treatment.

The filament in the Edison, Swan and Maxim is made from the same chemical substance, long known as cellulose, the formula for which is $C_6H_{10}O_5$. It possesses allotropic states in the forms of linen, cotton, paper and woody fibre, which differ widely in their physical properties, but show the above formula, by quantitative analysis, with the exception of a small percentage of impurities, which impurities may be neglected on account of their not being the cause of the difference of physical properties.

When subjected to dry destructive distillation, the hydrogen and the oxygen, together with the carbon in part, are separated only to unite again in different proportions and different groups to form new compounds, such as hydro-carbons CH, CH_2, C_2H_2, etc., and the two oxides of carbon, besides numerous secondary products and oils and tars and pyrogallic acid and wood spirits, and in fact all the products which are evolved in the manufacture of coal gas, and more yet, due to the fact that the composition of cellulose is more complex than that of coal.

Very unfortunate it is that, during the carbonization of carbon filaments, much of the carbon is lost in the form of carbonic oxide and dioxide and hydrocarbons.

By calculation from the formula, it is observed that the carbon in cellulose occurs by weight to the extent of 44 per cent. only of the weight of cellulose from which it is obtained. The calculation is here shown, thus:

$C_6H_{10}O_5$

C_6	$6 \times 12 =$	72
H_{10}	$10 \times 1 =$	10
O_5	$5 \times 16 =$	80
		162

$72 \div 162 = 44$ per cent. carbon.

Although the cellulose becomes reduced in weight by carbonization, yet the specific gravity is not diminished. On the contrary it is increased considerably. A bamboo fibre will float on water, while the filament made therefrom will sink; so also with other forms of cellulose. This is on account of a contraction which takes place by the effect of heat and chemical reactions. Nevertheless, the carbon filaments are by no means as dense as if the carbon of the cellulose entirely remained after carbonization. In kilns for the manufacture of charcoal, the carbon which is removed is a larger per cent. than that removed from carbon filaments during their process of manufacture. This greater loss is due to its combining with the oxygen of the air, which is not wholly excluded from the kiln.

Filaments, being so small, may be baked in a crucible and the air removed or displaced by sprinkling fine graphite or carbon dust about the forms containing the filaments, or by the introduction of coal gas through a pipe. The former process is probably preferable, as it allows the highest temperature possible, while coal-gas deposits large quantities of coke, which is likely to clog and build up the filaments irregularly when the temperature is maintained any length of time above the kindling point of coal-gas. By either process, however, or by both combined, the oxygen of the air is practically excluded so that there is no loss of carbon from this source.

By experiment I have found that the carbon filament of the Swan, Edison and Maxim lamps does not weigh 44 per cent. as much as the cellulose filament from which it is produced. Calculation, it will be remembered, shows the above figure. In the experiment the air was carefully excluded. The carbons on an average weighed only 35 per cent. the weight of the cellulose, showing a loss of carbon of about 8 per cent. This is a very serious loss, as it causes the carbon to be 8 per cent. more porous than were no carbon lost at all. Further experiment showed that the loss can be reduced by certain precautions in baking, in the case not only of vegetable fibres, but also in that of animal matter.

The precautions taken were to raise the temperature of the crucible (which can easily be accomplished by a gas furnace) to a point just below that of the melting point of cast iron.

This increasing of the temperature should be made so gradually as to occupy several hours, and then should be maintained an hour or so at this temperature. Afterwards, it may be raised to the highest degree possible for one or two hours more. By this method of baking, it was found, as was expected, that the carbon occurred in a quantity approaching 44 per cent. within 4 per cent. instead of 8 per cent. The experiment proved further the principle that hydrogen will unite with oxygen at a lower temperature than carbon will unite with oxygen or hydrogen. If the temperature were regulated in exactly the right manner, there would be no loss of carbon. As this cannot be done even in the laboratory, and as it cannot be done with certainty in the factory, this method of saving the carbon cannot be of much use commercially.

Mr. Swan has endeavored to make the carbon dense by making the cellulose or cotton thread dense. The same percentage of loss of carbon occurs, however, as in ordinary cotton thread. The cotton or linen thread in this process as carried on in the factory at Boston, is taken from one set of spools and wound upon another set of spools which are situated at such a distance from the first set as to allow space for several large tanks, the first of which is full of sulphuric acid, one-third water; the second with water and the third with dilute ammonia and the fourth with water.

The thread, by passing alternately below and above rollers, is caused to pass through the liquids in the order given. The sulphuric acid produces no chemical change, as is shown by subsequent analysis. It does, however, produce an important molecular change, so that the thread is three times as strong in tensile strength, is non-fibrous, of a pearly lustre, and as flexible as before treatment, its color still remaining as before. The rollers are rotated at such a rate as to allow the chemical to act on the thread about 15 to 20 seconds. Passing next into the tank of water, the excess of acid is washed away. The ammonia in the next tank neutralizes the remainder of the acid by turning it into sulphate of ammonia. The last tank washes away the sulphate so that the thread is wound upon the spools, having only to pass between sponges to dry them. One physical change not mentioned above is the change of dimensions. The thread is larger than previously and is not of a regular and uniform diameter, showing that it could not have been acted upon alike at all points, which is not surprising when it is remembered that only 15 seconds are allowed and that the acid is itself weakened in its action as each molecule attacks the thread, causing acid of different strengths to act on different parts.

Temperature of the acid, as well as its specific gravity and time of action, very often produces worthless material for carbonization. The diameter is made uniform by drawing it through a die-plate, whereby it may not only be made uniform, but may also be made into various smaller sizes than the original.

The parchmentized thread is next wound upon two carbon rods supported at the ends in holes bored into pine sticks. One of the sticks is removed during the winding, as it facilitates matters; especially as an instrument is employed which was invented by Mr. Swan for the purpose. It is wound about these two carbon rods in such a manner as to give the double curve noticed in the Swan filament.

I have often wondered whether Mr. Edison has ever tried to parchmentize the bamboo filament. It is already denser than cotton thread, as well as stronger, and yet nearly as flexible. There seems no reason why it cannot be thus changed in its physical nature by means of strong sulphuric acid. It is cellulose, just as truly as cotton, linen and paper are cellulose. For many years it has been known how to parchmentize paper, and yet it was only five years since Mr. Swan succeeded in making parchment from linen and cotton. I think that it would pay somebody to parchmentize wood. The new article would be valuable in many departments of industry.

(TO BE CONTINUED.)

*A paper read before the American Institute of Electrical Engineers, at Philadelphia, October, 1884.

Electrical Transmission of Power in France.

The important experiments on the transmission of power by electricity, which have been for a long time in preparation, between Paris and Creil, will enter shortly upon a practical phase. It will be remembered, says *Engineering*, that a powerful syndicate was formed some time since, to realize on a large scale the theories of M. Marcel Deprez, upon the electrical transmission of force, which theories received a practical development at the Palais de l'Industrie in 1881, at Munich, on the Northern Railway of France, and at Grenoble. This syndicate, composed among others, of the Paris house of Rothschild, the Creuzôt and Fives-Lille Companies, and the Société Industrielle et Commerciale des Metaux, subscribed a capital of half a million francs. The new series of experiments will be conducted between Paris and Creil. The programme has been prepared by a commission consisting of M. Marcel Deprez, M. Sartiaux, director of the Northern Railway of France, M. Aron, engineer to MM. de Rothschild, M. Cael, director at the Ministry of Posts and Telegraphs, and several other distinguished engineers. The late M. Ch. Bontemps was also a member of the commission. According to this programme, it is intended to furnish at the Creil Railway Station an initial motive power furnished by two locomotives,

each of 130 horse-power. These two engines will together drive the generating dynamo through four totalizing dynamometers, of a new type, by which it will be easy to read continuously the work transferred to the dynamo.

The generating dynamo will give a current of 20 ampères with an electromotive force of 7,500 volts, corresponding to about 200 horse-power absorbed. This energy will be transmitted to two smaller dynamos placed at the La Chapelle station in Paris, and which it is expected will develop 50 per cent. of the initial energy, one giving 60 and the other 40 horse-power, which will be employed to drive a number of machines for mechanical purposes, and for electric lighting. The dynamos were constructed by the Fives-Lille Company, and some idea of their dimensions may be given by the fact that 17,600 lbs. of copper wire has been used in winding the armature and field magnets. The transmission line, which is more than 70 miles long, and includes a complete circuit, will be laid overhead, and will consist of a cable with seven strands of silicious bronze made by M. Lazare Weiler, of Angoulême. These strands have a diameter of 1.9 millimetres, and together correspond to a single wire of 5 millimetres in diameter. The weight of the line will be from 2 to 2½ tons, and its total electric resistance is less than 100 ohms. Its breaking strength exceeds 1,900 lbs. From the initiation of the experiments the question of employing an insulated or non-insulated cable was warmly discussed. The necessity of insulation appeared at first to be of the greatest importance on account of the high tension of the current, and which it was intended to raise to 10,000 volts. Under these conditions the engineers of the commission representing the State wished to inclose the cable in a protective insulation, to prevent loss of current, especially during rain, and to avoid accidents. After a number of experiments it was decided to abandon continuous insulation, which would have the twofold inconvenience of great expense and imperfect protection. It was considered that accidents were little to be feared, since it would be a complete circuit fixed on high posts above the reach of ordinary interference, and a mixed system was decided on, which involved the insulation of about 47 miles of the line. This insulation, which was executed by the Société Générale des Telephones, is on the Berthoud-Borel system, by which the wires are inclosed in a lead envelope. Experiments with this arrangements have given quite satisfactory results, though it was found that with a current of 2,500 volts the cable thus covered acted like a Leyden jar, the envelope giving off static sparks during a considerable period. The inconvenience from this would be easily overcome by connecting the lead to earth. Or by breaking the lead envelope at intervals, and especially at the junctions, 500 yards apart, and making good the joints with hard rubber, the total surface of the condenser would be reduced, and the effects entirely prevented.

It is expected that all the preliminaries of the trials will be completed in a month or two, and that they will be carried out at the end of the year.

The Mind's Telegraph.

In a new edition of Goethe's prose writings is found the following suggestive passage:

One soul may have a decided influence upon another, merely by means of its silent presence, of which I could relate many instances. It has often happened to me that when I have been walking with an acquaintance and have had a living image of something in my mind, he has at once begun to speak of that very thing. I have also known a man who, without saying a word, could suddenly silence a party engaged in cheerful conversation by the mere power of his mind. Nay, he could also introduce a tone which would make everybody feel uncomfortable. We have all something of electric and magnetic force with us. * * It is possible, nay even probable, that if a young girl were, without knowing it, to find herself in a dark chamber with a man who designed to murder her, she would have an uneasy sense of his unknown presence and that she would tremble with fear.

THE TELEGRAPH.

THE BENNETT-MACKAY CABLE LANDED.—The Bennett-Mackay cable was landed at last at Manhattan Beach, Coney Island, on Oct. 18.

CABLE LAYING IN CANADA.—Mr. F. N. Gisborne has been laying new cables for the Dominion Government between Grosse Isle, the Island of New Orleans and L'Ange Gardien.

"PRESUMABLY FOR PROMPT DESTRUCTION."—An esteemed contemporary says that an official of the Western Union Telegraph Company in New York city has advised the managers of local offices that franks for election day business have been issued to Supervisor John I. Davenport and his aids, and instructed them to keep such messages apart from all others and forward them to the central office on Saturday—presumably for prompt destruction. This is not a regular course—if the story is true.

CABLE RATES.—A dispatch from London on the 18th of October, says: Insiders in the cable pool now state that the Mackay-Bennett cable people will not materially lower their rates beyond the present tariff. It is, however, understood that a vigorous attempt will be made to secure the patronage of large cable customers by offers of heavy rebates on their accounts. This method of obtaining custom and practically cutting charges will be resented by the members of the pool, who assert that they will fully meet every move of this kind by proportionately low rates, and thus make the battle sharp and, it is hoped, decisive.

UNDERGROUND WIRES IN PHILADELPHIA.—In a few weeks the Baltimore & Ohio Telegraph Company proposes to lay an ordinary six-inch water pipe on Chestnut street, from Fourth street to the Delaware, and on Second and Third streets, between Market and Walnut, for the purpose of testing an underground telegraph system. The cable of the Standard Underground Cable Company, containing two wires, and laid in Fairmount Park, from the Belmont pumping station to the Belmont Reservoir, has been tested and operated very successfully for telephone purposes. The cable in the park is about a mile in length, and contains two small wires.

THE TELEPHONE.

THE TELEPHONE IN BELGIUM.—During the month of September 15,064 messages were exchanged by telephone between the subscribers to the telephone companies holding concessions and the telegraph offices which form the points of junction. Of this number 3,342 originated in Brussels, 2,904 in Liége, 2,841 at Antwerp, 2,345 at Ghent, 1,691 at Charleroi, 985 at Louvain, and 956 at Verviers. It is stated that a definite understanding has been come to between the Belgian Government and the Bell Telephone Company for the working by this company of telephonic communications between towns on the Van Rysselberghe system; and that a few privileged individuals who have exchanged telephonic messages between Brussels and Antwerp find no greater difficulty than in speaking to any part of the capital.

A TELL-TALE BELL.—In order that the person ringing an electric bell may be able to tell whether, on making contact, the bell actually rings, Mr. Douglas Mackenzie, of England, has devised the following arrangement. Besides the press button, and let into the wall, is a simple telephone receiver of the Elisha Gray or Bell model, and consisting of an electro-magnet with a soft iron plate armature free to vibrate over one of its poles. The sounding or "clicking" core of Page may also be employed instead of the diaphragm armature. This electro-magnet is formed up in circuit with the bell and battery, so that when the bell is in action, with its contact interrupting the current, the telephone or electro-magnet will emit a musical note or hum, which, when heard by the person ringing the bell, informs him that the bell is ringing, always supposing that the current is strong enough.

THE TELEPHONE AT ANTWERP.—The telephone has entered so thoroughly into commercial life at Antwerp, says the London *Electrician*, that its suppression would now lead to something like a cessation of business. A local Bell Company started the lines about three years ago, the original subscribers paying only 200f. ($40) per annum, but new subscribers are charged half as much again. For this the company lays the wires, supplies the instruments, and maintains the whole in working order. The police stations and also the leading medical men are put in communication, and the current is on day and night. It may be said that at least one in five of the principal business houses is connected, together with all the leading hotels and cafés. What astonished us was to see the words "teléphone publique" put up at some quite minor *estaminets* or public houses, and we learned that the instruments were at the disposal of all and sundry who might call for a glass of beer, as the telephone brings custom to the tap. There are also three telephone offices on the boulevards, whence the public can hold converse with subscribers for the small charge of 50c. (10c.). These offices also serve as tramway stations and ladies' retiring rooms. All the fire brigade stations are of course connected, as also the office of the new water-works, owned by an English company. This company has also a private single wire telegraph between its office and the works at Walhaem, twelve miles off, that only cost $1,500, and seven minutes after the outbreak of a fire the pressure is increased all over the town.

THE ELECTRIC LIGHT.

DAMAGED BY FIRE.—A fire occurred on Oct. 18, from a defect in a boiler flue, in the building part of which is occupied by the New Haven (Conn.) Electric Lighting Co., and the company sustained damages put at $500.

OTTAWA CAN.—The Thomson-Houston light is in use at Montreal, Quebec, Toronto, St. John and Halifax, and preparations are being made by the Royal Electric Company to light Ottawa with it on an extensive scale, the dynamos to be run by turbines.

PORTLAND, ME.—The Consolidated Company, of Portland, Me., using the Thomson-Houston light, has increased its lights from 40 to 149 during the past year, and will, it is said, reach 250 lights at full prices this year, dating from Sept. 7. The balance sheet for the year ending on that date shows net earnings of $4,885 on a business of $16,696.

MISCELLANEOUS NOTES.

EXECUTION BY ELECTRICITY.—A bill has been introduced in the Legislature of Vermont, providing for the execution by electricity of murderers under sentence of capital punishment.

MR. W. H. PREECE.—This well-known gentleman left for England by the "Aurania" on the 22d inst. We had a call from him at the office of THE ELECTRICAL WORLD on the 20th, and in the course of conversation he expressed himself as highly pleased with the reception tendered to himself and his fellow countrymen, and with the results of his sojourn in this country. Mr. Preece goes back with important changes in view in his own department, suggested by his observations here.

PRINTING BY ELECTRICITY.—In its description of the Philadelphia Exhibition, the London *Electrical Review* is kind enough to say of THE ELECTRICAL WORLD exhibit: "Our contemporary, with its usual energy, has during the Exhibition printed its issues in the Exhibition building, obtaining the power by the medium of a Daft motor, from one of the dynamos stationed some distance away in another part of the building. The printing is also accomplished from electrotyped reproductions, and not from the type itself."

THE VAN DEPOELE ELECTRIC RAILWAY.—It is proposed to put a Van Depoele Electric Railway in the grounds of the Exposition at New Orleans, like that operated successfully in Toronto. A company has also been organized in St. Paul and Minneapolis to build and operate a Van Depoele road between the two cities, and it is said that there are excellent prospects for its early construction. We understand that Mr. George S. Bowen, the active President of the Elgin Electric Light Company, is looking after the New Orleans project.

POSITION OF THE POLES OF MAGNETS.—Messrs. W. Hallock and F. Kohlrausch have made a number of experiments on ordinary long bar magnets in order to determine with exactitude the true position of the poles in the length of the bars. Fourteen magnets were used, some of various conditions of hardness, and in general they were in the form of steel cylinders magnetized in the direction of their axes. Their results, taken in connection with those of Schneebeli and Helmholtz, agree in showing that the effective poles of a magnet are about one-twelfth of the distance of the length from the ends. This result is, according to the observers, in all probability correct to within five per cent.

LIGHT AND THE ELECTRIC RESISTANCE OF METALS.—Mr. Arthur E. Bostwick has made an elaborate series of experiments on the supposed influence of light in altering the resistance of metals. Since the diminution of resistance of selenium, when a ray of light falls upon it, was discovered by Messrs. May and Willoughby Smith, Dr. Richard Börnstein has attempted to show that not only selenium and tellurium possess the property in question but other metals, such as gold, silver, platinum, also possess it. This effect was not verified by Siemens and Hausemann, of Berlin, and now, says *Engineering*, Mr. Bostwick's researches have not established the fact asserted. His conclusion is that "if light causes any diminution in the electrical resistance of metals, it probably does not exceed a few thousandths of one per cent.

OBITUARY NOTE.—Thomas Maguire, for many years an attaché of the Boston *Herald*, died in Boston, on the 22d, of Bright's disease. He was born on an ocean steamer on the passage from Queenstown to New York, in 1841. His parents settled in Hinsdale, Mass. The first situation that he obtained was as water boy on the old Western Railroad. Subsequently he sold papers on the train and then was employed as brakeman, from which position he became a reporter on the Springfield *Republican*. He was afterwards connected with the New York *Herald*, the Boston *Journal* and the Boston *Herald*. He was well known as a special correspondent of ability. He was an old telegrapher and always took great interest in telephonic matters. Contributions from his pen have appeared from time to time in the columns of THE ELECTRICAL WORLD and THE OPERATOR.

STOCK QUOTATIONS.

Telegraph, telephone and electric light quotations are as follows on the New York Stock Exchange, Boston Exchange, and elsewhere:

TELEGRAPH.—Mutual Union, b 13; Postal first, b 27; Western Union, b 66¼.

TELEPHONE.—American Bell, b 182, a 183; Erie, b 18; Mexican, b 1¾; New England, b 28¾, a 29; Tropical, b 1¼.

With regard to the present dissensions in the Erie management, the Boston *Herald* of the 22d says: Director C. E. Adams of the Erie company is out in a letter to one of the Lowell papers, in which he throws the blame for the present wrangle in the management upon the president and late manager, and he furthermore makes it clear that there is not room for both himself and those officers in the board of direction. The president and manager both resigned, and the further resignation of both from the board is said to be at the disposal of their associates. Whether Mr. Adams will resign is not learned. There are said to be plans afoot which will harmonize differences, by resignations or otherwise, and which will give the company a management more concentrated than that which rests with a board of nine directors.

The *Mexican Financier* reports the Mexican Telephone Company prospering under Manager Guiraud, and says there is a prospect of an extension of its business in the near future.

Speaking of the New England Company, the Boston *Herald* recently remarked: "The debt of the company is gradually disappearing, and 1885 may possibly see a resumption of dividends. It is a fact not generally known that General Manager L. N. Downs severed his connection with the company Oct. 1, his resignation having been tendered a month before, to take effect upon that date. Mr. Downs resigned to engage in private business. Vice-President Ingham succeeds Mr. Downs as manager.

ELECTRIC LIGHT.—Market inactive.

BUSINESS NOTICES.

MAHOGANY.—Manufacturers who like a handsome wood for cases, or the wood parts of electrical apparatus, are referred to the advertisement of H. Otis, of New Orleans, who is a direct importer of mahogany, and can therefore supply it at bottom prices.

MESSRS. SAMUEL KYLE & CO. (formerly associated with G. H. Pride), will occupy the old quarters at 23 and 25 Dey street, and carry on the business as electrical engineers, paying special attention to the construction and maintenance of lines for telegraph, telephone and electric light service. They pay also great attention to house and office work.

ELECTRICAL INSTRUMENTS.—Attention is called to the card of Paul Hoenack, 191 Worth street, New York, on page VII. He has been for some years manufacturing electrical instruments for all the most prominent electricians connected with telegraphy, telephony and electric lighting. He has command of all facilities, and his ability to grasp the details of any new piece of mechanism is evidenced in his work.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

Edited by N. S. KEITH, Electrical Engineer and Expert, 9 Murray Street, New York.

PATENTS DATED OCT. 7, 1884.

Accumulating Battery; N. Basset, Paris, France...306,051
The electrodes are two plates of retort-charcoal or agglomerated carbon, covered with natural peroxide of iron or granulated coicothar, wrapped in blotting-paper and held together by one or more strings. These plates form the electrodes, which are placed without a diaphragm in a more or less concentrated solution of protochloride of iron, and the whole forms an element of an accumulator or secondary battery.

Alarm Apparatus for Automatic Fire-Extinguishers; C. C. Worthington, Irvington, N. Y.. 306,201
Consists in providing fire-extinguishers or sprinklers with electrical circuit-connections having circuit-closing mechanism which is so constructed and arranged that the moving force of the water set in motion by the release of the valve or other device which confines the water in the sprinkler will operate the circuit-closing mechanism, so as to make operative the electrical circuit, and, through a suitable alarm mechanism, give notice of the fact at any desired point.

Alarm Apparatus for Automatic Fire Extinguishers; C. C. Worthington, Irvington, N. Y.... 306,202
Consists in providing fire-extinguishers or sprinklers with electrical circuit-connections and means whereby the water escaping from the sprinkler, whether in large or small quantity, will make operative the electrical circuit and through a suitable alarm mechanism give notice of the fact at any desired point.

Apparatus for Working Electric Bells; W. F. Horn, Carlisle, Pa..... 306,255
The bell is rung by immersing only one of the plates in the battery-fluid, the other plate being continually therein.

Central Office Instrument for Telephone Lines; J. P. Stabler, Sandy Spring, Md..... 306,360
Consists, first, in a normal ground-loop connection for the line, whereby the break in the circuit through the instrument-line to ground is bridged when the instrument is not in use without throwing its motor-magnets and other initial resistance into the line with which it may be connected; second, in the strong or re-enforce current switch-key; third, in a resistance-coil in the motor-magnet circuit, but not in the strong or re-enforce circuit, whereby the effective margin or difference in strength is increased without corresponding increase in the size of the generator.

Conductor for Telephone and Telegraph Purposes; W. Jamieson, New York City..... 306,256
The direct and return wires are helically wound upon a conducting-core composed of one or more single conductors.

Electrical Igniting Device for Gas Engines; S. Marcus, Vienna, Austria-Hungary..... 306,339
An eccentric on the shaft moves a lever carrying a contact-piece within the cylinder; and thus circuit is made and broken to produce the igniting spark.

Electric-Arc Lamp; E. Thomson and E. W. Rice, of Lynn, Mass..... 306,118
Consists in keeping the circuit-controller in proper position to retain the starting-circuit in the required relation for starting the lamp when the current is turned on, by means of an electro-magnet whose coils are in a branch around the carbons closed when the current begins to flow, so that it will be energized to hold the contacts of the circuit-controller closed until the carbons are permitted to come together, whereupon the magnet-coils will be shunted, and the circuit-controller will thus be permitted to return to a position in which the starting circuit or coil will be opened or otherwise rendered ineffective, and will remain in such condition while the lamp continues to act.

Electric Arc Lamp; E. Thomson and E. W. Rice, Lynn, Mass..... 306,119
Consists in dividing the regulating-coils of high resistance in a derived circuit around the carbons into two portions, one of which portions is shunted or cut out of circuit when the lamp is out of action, or at the moment the current is turned on, so that when the current begins to flow it flows through the unshunted portion. By reason of the comparatively small resistance of the latter as compared with the whole resistance of the derived circuit regulating-coils, sufficient current flows in the unshunted coils to attract the regulating armature or lever from its extreme retracted position, or to otherwise act upon the lamp mechanism so as to put the lamp or its parts into working condition or relation, whereupon the shunted or cut-out portion of the coil is automatically put into circuit, and the current thereupon flows through the whole regulating-coil of high resistance in the ordinary way, and the operation of feeding the carbons or controlling the position of the same then proceeds under the controlling action of the fluctuating current in the coil.

Electric-Lighting Gas-Burner; A. L. Bogart, Jamaica, N. Y..... 306,128
Consists in the combination in an electric-lighting gas-burner having a stop-cock operated in the usual manner, without a ratchet or other device for producing a step-by-step movement, of mechanisms for turning on the gas, producing a spark, and carrying the movable electrode beyond and out of reach of the flame, and whereby said movable electrode is prevented, in its return movement, from either being brought into the flame or into contact with the fixed electrode until the gas has been entirely shut off from the burner in the return movement.

Electric Lock; H. P. Roosevelt, of New York City.. 306,179
Consists in the combination, with the armature of the magnet, the swinging plate, its spring, and the second bolt, of a trip-plate interposed between the armature and swinging plate, and a spring and stud connecting the trip-plate and the second bolt.

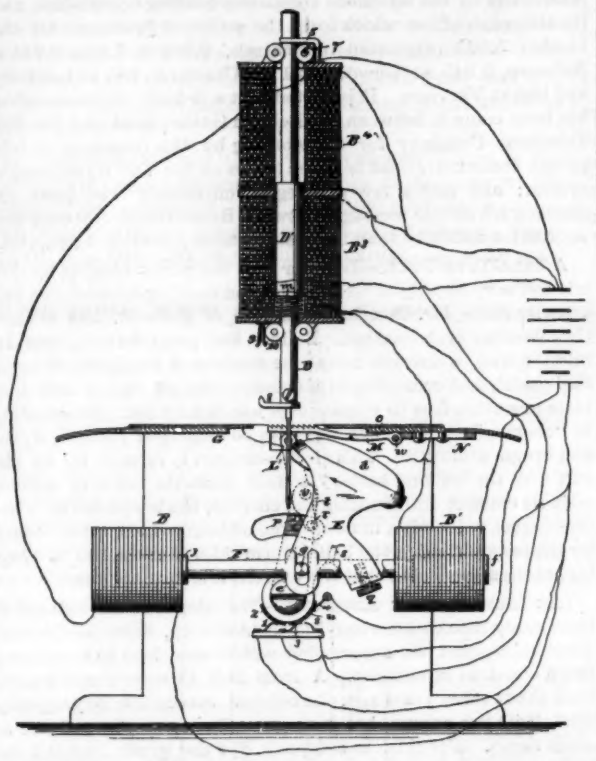
Electric Railway; E. M. Bentley, Brooklyn, N. Y.. 306,315
Consists in an arrangement whereby a number of electrical locomotives may be run in series, and in the detail of construction and operation of the road, motors and connections.

Means for Diminishing the Consumption of Battery in Normally-Closed Circuits; C. Cummings, Reno, Nevada..... 306,225
Devices to put into local circuits great resistances while the instruments in the circuit are idle.

Metallic-Circuit Telephone System; E. T. Gilliland, Boston, Mass..... 306,240
Improvement in connection with No. 306,238.

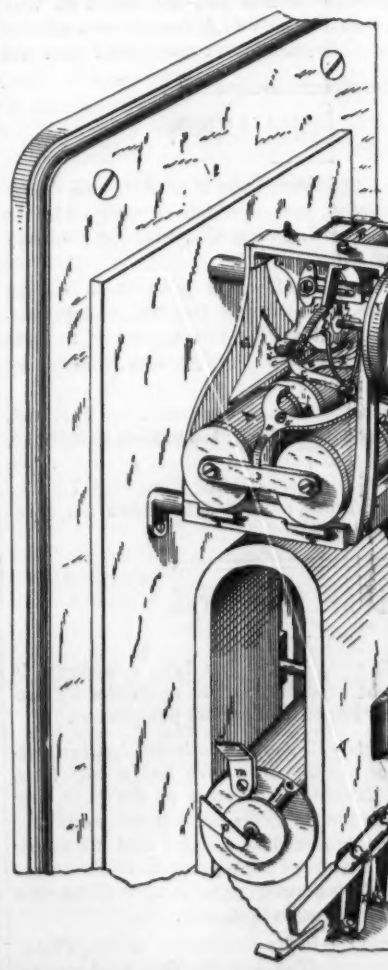
Multiple-Circuit Changer; E. T. Gilliland, Boston, Mass..... 306,241
Consists in combining telephonic and signaling instruments, or either, with any number of normally-open or disconnected loop-terminals, each adapted to be inserted in a separate main-line circuit and to become part thereof, so that the same telephones may be used in connection with any number of lines: in providing each pair of loop-terminals with a controlling spindle or handle, whereby it may be pushed into position and held there; in combining with the said circuit-changers a bar constituting a telephone-support, and actuated automatically when the telephone is removed from its support, and carrying a suitable retaining device by which any circuit-changer, when pushed into position so that the telephones are included in a line, may be retained in such position independently of any positive action of the operator, and allowing any or all of the circuit-changers to resume their normal position and withdraw the instruments from connection with any main line when the telephone is replaced in its support, so as to make such withdrawal dependent on the replacement of the telephone; and, finally, in combining with the supporting-bar and circuit auxiliary circuit-changers adapted to transfer the circuit of the instrument-loop from the calling-generator to the telephones, and vice versa, and likewise to open and close the circuit of the local transmitter-battery.

Electric Sewing Machine; W. C. Shaffer and J. L. Poalk, Philadelphia, Pa..... 306,288
A preferable construction where a reciprocating shuttle is used is shown in detail in Figs. 3, 4 and 5, where the shuttle *d* is carried by a cradle at the upper end of a pivoted carrier, *E*, as in many machines in use, the shuttle sliding on a vertical face-plate,



F, extending downward from the bed-plate *G* of the machine, and the carrier-arm *E* being pivoted by a pin, *e'*, to the side of said plate. The carrier is oscillated by the reciprocation of a bar, *F*, carrying two soft-iron cores, *f f'*, which extend into solenoids *B B'*, the latter and the cores being relatively so arranged that a current through the coils of one solenoid will carry the bar *F* in one direction, an opposite movement being made when the current passes to the coils of the other solenoid. The connection between the bar *F* and the carrier-arm *E* is by means of a pin, *g*, which enters a slot in the bar, and by arranging this pin near the pivot *e'* the requisite throw of the shuttle is secured with a comparatively small movement of the bar.

Individual-Call Instrument for Telephones; J. P. Stabler, Sandy Spring, Md. 306,361
An improvement on patent No. 265,454.
When it is desired to "call up" the central office, the telephone is upon the hook, and the switch upon the detent or unison shunt



i. The push-button *o* is pushed in to break contact with button *l*. When the crank is turned, the current will then be, generator-frame to out post *n*, and from springs *p* by wire 2 to contact-spring *k*, lever *j*, and wire 1, to detent-magnet *R*, index-switch *L*, motor-magnets *A A'*, and post *h*, to line. When "call" is answered, take the telephone from the hook and the currents will be, generator-frame by wire 3, to post *n* and spring *p*, and wire 2 to telephone-wires 6 and 5, to secondary coil *W* of the transmitter-wire 4, to contact-spring *q*, lever *j*, wire 1, detent-magnets *R*, index-switch *L*, motor-magnets *A A'*, and post *h* to line. This completes the several connections under the various conditions of use. The primary coil *U* of the inductorium is in the short local circuit of the battery *X*, as is usual.

Printing Telegraph; H. Van Hoevenbergh, Elizabeth, N. J..... 306,297
Consists in effecting the escape and control of the type-wheel through the agency of magnetism, instead of the usual mechanical means.

Printing Telegraph; C. G. Burke, Richmond Hill, N. Y..... 306,055
The transmitting key-board is circular in form, and is provided with more than one key corresponding to the letters of the alphabet most commonly employed—that is to say, each letter or character is provided with a number of keys proportionate to the frequency of its employment in ordinary use. The keys are also arranged in such a manner that each and every key falls in a different radial line of the circular key-board. Beneath these keys is rotated a contact-arm, which is designed to form an electrical connection with any key which may be depressed, and also to raise such key and restore it to its normal position upon making such contact. The keys themselves constitute one terminal of an electric circuit, and the revolving arm the other; hence, by the contact of the arm with one of the keys an electric circuit is completed, which may be employed either for actuating a message-preparing device or for directly actuating a receiving-instrument having upon the periphery of its type-wheel a series of characters corresponding to the keys of the transmitter.

Printing Telegraph; C. G. Burke, Richmond Hill, N. Y..... 306,056
For the purpose of obtaining alternate electric currents adapted to actuate the escapement device of the receiving instrument, a pole-changing device is employed at the transmitter, which is adapted to alternately connect the poles of two opposing batteries with the main line. The impulses thus transmitted are preferably caused to traverse an artificial resistance, which in effect, to a certain extent, diminishes their strength.
Two transmitting key-boards are employed in connection with the pole-changing device, which are adapted at the proper times to complete the connections of a shunt-circuit around the artificial resistance, provided a key of one of the key-boards be depressed. An increase in the strength of the current occasioned in this manner is employed for effecting an impression from one or the other of the receiving type-wheels, accordingly as the key employed for effecting the increase is located upon one or the other of the transmitting key-boards.

Relay for Printing-Telegraphs; J. E. Smith, New York City..... 306,187
The helix or helices of the magnet is made in two parts, and one of these parts is in circuit as usual, and the other part and the armature-lever in a branch or derived circuit, so that said lever, on completing its movement toward the magnet, will send a derived current through one portion of the helix or helices, so as to partly neutralize the effect of the current through the other portion of the helix or helices, and thereby prevent any increment in the power of the magnet after the lever has closed the derived circuit.

Telephone; C. E. Allen, Adams, Mass..... 306,044
Consists of a number of pairs of electrodes so arranged that the current from a powerful battery passes through them in multiple arc, and thence through the primary of a large induction-coil. The secondary of said induction-coil forms part of the main line containing the receiving-instrument. The relations of these electrodes to each other is controlled by variations in electro-magnets operating the same, the said magnets being situated in a local circuit including a transmitter of the ordinary construction.

Telephone Circuit and Apparatus; E. T. Gilliland, Boston, Mass..... 306,238
Consists in a series of sub-stations, and a series of main lines extending between and entering all of the sub-stations, a looping-in switch being provided at each station, whereby the subscriber may introduce his signaling mechanism and telephones into any one of the main-line circuits, and call and converse with the sub-stations normally connected thereon.
It consists, also, in connecting the said apparatus at each station normally in any particular one of the main lines, so that when the entire system is quiescent a certain number of stations—say five—are normally connected in and with No. 1 main line, five more with No. 2 main line, five more with No. 3, and so on. Thus any station may call and communicate with any other station on the same line without a change in its connections, and may, furthermore, connect with any station on any other line by transferring his instrument-loop to the line.

Telephone Circuit; E. T. Gilliland, Boston, Mass... 306,239
Improvement in connection with No. 306,238.

Telephone-Support; T. N. Vail, Boston, Mass..... 306,296
Consists in a yoke-piece of soft metal or other pliable material, fitting over the shoulders and adapted to rest firmly thereon, being also maintained by a suitable strap and buckle extending down the back and attached to a belt encircling the waist of the wearer. The yoke-piece carries at one or both sides a horizontal rod supporting an upright standard. The telephone itself is held by a clamp fixed to a sleeve which is adapted to slide upon the upright standard. The sleeve is perforated throughout its entire length, and may, therefore, simply by turning it upside down, be transferred from the standard on one side to the standard on the other.

Telephone Switch; S. H. Bartlett, of New York City..... 306,050
Consists in a switch device arranged in the conducting-cord leading to the telephone, and having such connections and being so located that in the ordinary use of the instrument the necessary switching of the circuits will be automatically accomplished.

Underground Telegraph Line; H. A. Chase, Lynn, Mass..... 306,057
Details of an underground conduit for electric wires.

Electric Alarm and Call-Bell System for Hotels, etc.; W. T. Kellogg, Cohoes, N. Y..... 306,084
Apparatus calculated, first, to provide a more perfect system for interchanging signals and alarms between the office and any or all of the other rooms; second, to render the apparatus for sounding the alarms in rooms automatic in its action; third, to provide for each room containing an alarm-bell a suitable switch for automatically closing the line leading through the alarm-bell, which switch may be used, as occasion requires, for operating an annunciator or other apparatus placed in the office for communicating signals from the room to the office; and, fourth, to provide for the office a separate circuit-closer for each wire connecting with an alarm-bell, which circuit-closer may be automatically thrown out of action from the room to which it is appropriated.